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MILITARY HYGIENE

THE ELEMENTS OF
MILITARY HYGIENE

ESPECIALLY ARRANGED FOR OFFICERS AND MEN OF THE LINE

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PREFACE TO THE THIRD EDITION

THE World War just closed did not teach us much in the way of new principles of hygiene, but it did emphasize the importance of much that was old and of things formerly regarded in our army as relatively unimportant. The new knowledge gained is sufficient not only to justify but also to demand a revision of this book.

It was the writer's fortune to be in positions which afforded him unusually good views of the strength and weakness of our hygienic practice, both in this country and in the American Expeditionary Force, and it is his hope that he has been able to present the subject more advantageously in consequence.

It is still his opinion that the education of the line officer and the enlisted man in elementary military hygiene is of fundamental importance and well worth all the effort and time that can be devoted to it.

May, 1920

PREFACE TO THE SECOND EDITION

Since the first appearance of this book there has been a notable and gratifying increase in the interest that line officers and men have manifested in matters of hygiene and sanitation, and a corresponding increase in the effectiveness of disease-preventing measures. That this improvement has occurred is not necessarily evidence that the book has been instrumental in bringing it about, but expressions of opinion from various officers have led me to think it a possible factor, and have in that way encouraged me to revise and in parts rewrite it, while a supplementary chapter has been added, in the belief that interest in the subject entitles the reader to a knowledge of advances more recently made, and in the hope that such interest and the usefulness of the book may be increased.

December 8, 1914

PREFACE

There can be little or no doubt that the sanitation of the army would be greatly improved if line officers and enlisted men should become more interested in the subject, and coöperate more freely and intelligently with medical officers in the efforts to promote it.

This book is written in the hope that it may both inform and interest them and so gain for the medical officer the sympathy and coöperation that he always needs, but now too seldom has. It is also hoped that medical officers themselves, especially those of the volunteer service and militia, may find the book useful in their dual capacities of administrators and teachers.

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THE RECRUIT AND HIS ENVIRONMENT

Health and a good constitution are better than all gold; and a strong body than wealth without measure. ECCLESIASTICUS 30 : 15

MILITARY HYGIENE

CHAPTER I

THE RECRUIT

One of the principal factors in military hygiene is the individual soldier, or, as he comes from civil life, the recruit. If he enters the service in good physical condition, in good health, and with sufficient intelligence to apprehend and apply the instruction he receives in military hygiene, the problem is almost half solved. The final acceptance or rejection of recruits now rests almost entirely with medical officers; but in certain ways line officers exercise a considerable influence in the matter: in the acceptance at the recruiting station, and in requesting special authority to enlist because of special qualifications. For these and other reasons it is important that they should keep well informed as to the requirements necessary and the qualifications desirable in recruits. However, the standards applicable to recruits must vary from time to time so as to adjust supply to demand so far as is practicable. Furthermore, they must vary according as the army is a volunteer or a drafted one. The great war through which we have recently passed and the raising of armies of millions showed the practical necessity of not allowing many disabilities, which would have been causes of rejection from the old volunteer army, to excuse from service under the draft law. The most notable and important of these changes will be mentioned in the course of this chapter.

Age. The age limits for first enlistments in ordinary

times are from eighteen to thirty-five years. The draft law as first passed called to registration all men between the ages of twenty-one and thirty-one years. Later, and in order to place at the disposal of the Government the entire male personnel eligible for military service, the age limits were extended and all males from eighteen to forty-five years were required to register. In practice, however, our draft army was drawn almost entirely from men between the ages of twenty-one and thirty-one, a very satisfactory age group.

After the age of thirty years a man's habits of body and mind are fixed, he takes instruction less readily, his body may have begun to deteriorate, particularly if it has not been well cared-for, and, in many instances, he seeks the service as a refuge, after failing in other walks of life. Many good men may be obtained before the age of twenty-one and between the ages of thirty-one and thirty-five, but in general the draft-age group is the more satisfactory.

Size. The size of the recruit is not a matter of the greatest importance, provided that the development is normal and the man strong and active, except as it applies to assigning him to duty. It is obvious that a very large and strong man is better suited for coast-artillery work than for the cavalry, and that a small, wiry man is in that respect better for the cavalry. The proportions of weight and chest measurements to height are published from time to time in general orders, and those proportions usually represent very well those of strong, well-developed men. An increase of weight, if associated with great breadth of shoulder and large chest measurement, is not necessarily harmful, being usually indicative of strength and endurance.

The sturdy, stocky Japanese coolie exemplifies this. Obesity, whereby the man is burdened with his own weight, is of course objectionable.[1]

[1] The following table copied from the *Medical Record* of September 5, 1908, and compiled from the data of the Mutual Life Insurance Company of New York, by its Chief Medical Director, is interesting as indicating somewhat "the influence of overweight and underweight on vitality." The weights considered normal by the insurance company are somewhat in excess of those prescribed by the War Department, the increase averaging about 10 pounds at the ages 25–29, and for heights below 70 inches. A weight 20 per cent below the average is considered "underweight," and 20 per cent above the average, "overweight."

TABLE SHOWING THE PERCENTAGE OF DEATHS IN ALL CLASSES, AND SOME INDIVIDUAL DISEASES, AMONG OVERWEIGHTS AND UNDERWEIGHTS, AND THE GENERAL EXPERIENCE OF THE MUTUAL LIFE INSURANCE COMPANY

Causes of Death	*Overweights*	*Underweights*	*General Experience*
Class I. General Diseases — Acute	9.67	9.28	8.90
Typhoid fever	4.00	3.06	3.94
Malaria fever	1.27	1.21	1.24
Influenza	1.47	2.04	1.00
Class II. General Diseases — Chronic	13.07	24.59	19.56
Tuberculosis	2.93	16.98	12.42
Cancer	4.40	5.57	4.18
Diabetes	3.40	0.65	1.25
Class III. Diseases of the Nervous System	19.08	12.16	17.44
Cerebral Congestion and Hemorrhage, Cerebral Softening, Paralysis	14.14	8.47	12.32
General Paralysis and other forms of mental alienation	1.80	0.84	1.30
Class IV. Diseases of the Circulatory System	16.01	11.69	11.85
Organic diseases of the heart	12.94	8.54	10.76
Class V. Diseases of the Respiratory System	8.54	15.78	11.86
Pneumonia	6.87	12.34	9.03
Class VI. Diseases of the Digestive System	10.61	8.54	10.19
Cirrhosis of Liver	3.47	0.65	1.00
Class VII. Diseases of the Genito-urinary System	12.01	7.42	8.78
Bright's Disease and Nephritis	11.07	5.30	6.66
Class IX. Diseases of Skin and Cellular Tissue	1.20	0.47	0.50
Class XI. Old age	None	2.04	1.50
Class XII. Violent causes	7.07	5.57	7.42
Casualties	4.20	3.43	5.21
Suicides	2.87	2.14	2.20
Class XIII. Ill-defined	2.60	2.50	3.98

The standards prescribed for the drafted men varied from time to time, but the last set prescribed allowed variations in height from sixty to seventy-eight or more inches, and in weight from one hundred and fourteen pounds upward, except that obesity interfering with physical activity was a cause for non-acceptance.

Chest. The chest should be freely mobile, that is, both sides should move freely, symmetrically, and equally, in expanding and contracting. The measured chest expansion should generally correspond with the figures published in the general orders; yet it should be remembered that one man with very ordinary lung capacity may, by use of the shoulder and back muscles and retraction of the abdomen, show an apparent expansion of 3½ inches, while his companions with a capacity as great, may, through ignorance of tricks or of what is desired, show only 1½ inches. It is desirable that the chest be fairly large, to afford ample room for the free working of the heart and lungs, as on such finally depend both strength and endurance. A generally well-developed and strong man will show well-developed and prominent chest muscles.

The deviation from peace-time standards of chest measurement was less marked in the examination of drafted men than that from many other standards.

Certain types of chest frequently indicate a predisposition to, or the actual existence of, disease, and demand careful consideration even when not constituting actual causes for rejection. The long, narrow chest, with prominent or "winged" shoulder-blades, depressed or flat below the collar-bones, and forming an acute angle at the divergence of the ribs below the breast-bone, frequently marks a predisposition to consumption.

A large, barrel-shaped chest, as deep from front to back as transversely, and showing a relatively small movement, is often associated with emphysema and asthma.

A chest more prominent on one side than on the other is apt to be associated with curvature of the spine, or old or chronic pleurisy.

Marked prominence or depression of the breast-bone, especially if associated with "beading" or lumps on the ribs near the breast-bone, frequently results from rickets, and may be accompanied by other bone deformities.

Abdomen. The abdomen should be well muscled, and firm when the applicant is standing. It should move easily and naturally in respiration, should not be pendulous, and should be firm, particularly in its lower parts, just above the groin. Weakness here will be indicated by a bulging if the patient strains, as at stool, or if he stands on his toes and coughs hard. Such bulging, especially if it be marked or shows a tumor-like swelling, indicates a predisposition to, or the actual existence of, a hernia.

The umbilicus or navel is another frequent site of hernia, and should be noted in that connection, as should any abdominal scars resulting from operations, as for appendicitis. Another, though less frequent, site of hernia is the femoral. This is shown by a fullness or swelling in the lower part of the groin, in the highest part of the thigh rather than in the lowest part of the abdomen.

Large masses or tumors that can be felt through the abdominal wall, or that can be seen to produce inequality or fullness, are causes for rejection.

Distention or prominence of the veins on the surface of the abdomen, or a varicose condition of them, is generally an evidence of impaired circulation or liver disease, and should cause rejection.

Hemorrhoids, or piles, while apparently not connected with the abdomen, are the result of distention of the rectal veins, and may be due to liver disease, to abdominal tumors, to constipation, or other intra-abdominal conditions. They are manifested as tumors, usually of a bluish color, within or about the anus, which vary in size from that of a small pea to that of a man's thumb. Of themselves they are not a cause for rejection unless of large size or producing symptoms, but their presence should always be noted. Internal piles are not visible, and usually make their presence known by burning or irritation in the rectum, or by the passage of blood in the stools. In examining for piles, note should also be made of other abnormal conditions of or about the anus, such as fissures or cracks in the skin and mucous membrane; fistulas, little openings near the anus from which there may be a slight discharge of pus or fecal matter; or abscesses or boils. Any of these conditions may so disable the man as to unfit him for service.

A history of abdominal trouble, such as severe indigestion, gallstone colic, vomiting of blood, should cause rejection.

The departure from ordinary standards which the later draft examination standards prescribed was considerable; for example, many hernias, some cases of recurring inflammation of the gall bladder, large groups of digestive symptoms, early pellagra and moderate enlargement of the liver and spleen were not al-

lowed to disqualify for service. Whether the service obtained from men having such defects was in general worth the pay drawn is not known, but the departures from standard were doubtless made for the purpose of preventing abuses rather than of obtaining the services of a few men of doubtful value.

Head. The examination of the head is very important, as revealing defects in most of the special senses and as offering important evidences as to the man's character, habits, and abilities. The evidence on the latter points is to be gained largely from the shape of the head and the expression of the features, and, while such evidence is not always reliable, certain heads and facts are so distinctly indicative of stupidity or vice that there should be no hesitation in rejecting their possessors. Then, too, hideous or disgusting deformities should at once cause rejection, for the sake both of the victim and those with whom enlistment would associate him, even though they are not of a character to incapacitate directly. Abrupt depressions of the dome of the skull or considerable bony defects should cause rejection. The vision and hearing should be tested in strict accordance with the regulations governing the subject, and failure to meet the requirements is cause for rejection.

Eyes. In addition to the test for vision, however, the eyes should be examined for any signs of inflammation, redness, watering, drooping of the lids, scars or deformities, granulations, styes, or boils, undue prominence of the eyeball, inability to move the eyes in all directions, and discoloration or blurring of the cornea.

The visual requirements were lowered during the examination of the drafted men and the regulations placed great emphasis on the examination for and de-

tection of malingering, a question rarely arising in voluntary enlistment. Many conditions which exclude from voluntary service were accepted.

Ears. Unusual precautions and tests for the detection of malingering were also used when deafness was alleged as an excuse from drafted service. The ears, in addition to the tests for hearing, should be examined for any discharge, whether watery or purulent, and if present it should be a cause for rejection.

Nose. The nose should be examined as to its freedom from obstruction, by having the applicant close first one side and then the other with his fingers and then breathe and blow through the free side. Incidentally this may call attention to a foul-looking discharge or a foul-smelling breath, either of which may justify rejection. A sunken or much-scarred nose is often an indication of syphilis, while a red, bulbous nose, even if not indicating alcoholism, is sometimes an indication of indigestion. It should be noticed that the man habitually breathes through his nose.

Mouth. The mouth and throat should always be carefully examined.

Teeth. The condition of the teeth is the first point to be noted here. It is desirable that all should be present and good, but there must be at least enough to permit of proper mastication of the food, and for this purpose at least six grinders are demanded, three above and three below, and so disposed as to permit their effective use. Enough of the front teeth should also be present to permit of the biting of food and to preserve the symmetry of the face. Six incisors, three above and three below, are demanded. At times men are accepted with no upper teeth, but wearing plates. This should only be

done by special authority and in special instances. Insufficient or poor teeth are apt to produce digestive disturbances, particularly on campaign, when hard bread may be issued, and when the preparation of the food in general may not be as good as in garrison. The examination of the teeth should not only relate to their presence and the presence or absence of cavities, but also to their state of cleanliness. Neglected, filthy teeth and gums may seriously menace the general health, while they certainly predispose to loss of teeth, and, in many instances, indicate general carelessness or filthiness. Sores or ulcerations on the lips, tongue, gums, or inner sides of the cheeks should be carefully noted, as they may indicate syphilis or other general disease, and should at least lead to further and more careful search for syphilis. The same remark applies to milk-white patches, seen especially on the tongue.

Gums. In ill-kept mouths the gums may be spongy and bleed spontaneously or on pressure, or pus may exude from between them and the teeth; or they may be greatly retracted and expose the roots of the latter.

In these and other cases the teeth may all be present, yet in such poor condition as to forbid proper mastication, or to threaten their early loss.

Throat. The most common and easily detected throat trouble is enlargement of the tonsils. This condition usually indicates a liability to frequent attacks of sore throat, and should always excite inquiries as to this, and while not necessarily a cause for rejection, unless very marked, should be noted as a point against desirability. Ulcers, white patches, membranes, and an appearance of acute inflammation in the throat, should cause rejection.

Hoarseness, or loss of voice, or cough, should at least delay, and if persistent prevent, acceptance.

Tongue. Numerous scars on the tongue, lips, and cheeks, unless clearly and certainly accounted for otherwise, should cause rejection as being probably due to bites during epileptic fits, or to syphilitic or other ulceration.

Too much importance should not be attached to a coated tongue, but a raw-looking, bright red, or tremulous one should direct careful scrutiny to the general condition and the habits.

Lymphatics. Enlarged lymphatic glands, or "kernels," are most frequently noticed in the neck or under the jaw. They are frequently indicative of inflammation or ulceration in other near-by regions, especially the mouth or throat, and their presence should lead to careful examination for such conditions; but at times their presence is indicative of a general infection, such as syphilis. Usually, if the enlarged glands are numerous, or the enlargement great, they constitute a proper cause for rejection. When the enlargement is localized at one part of the neck only, it points to an infection entering at a part near it. Thus such a gland at the angle of the jaw may be due to inflammation of a tonsil of the same side; one under and near the jaw to a bad tooth, etc. Enlarged lymph glands were not usually causes of rejection from the draft, nor was ordinary goitre.

Scalp. The scalp should be carefully examined as to its cleanliness and general care, for the presence of lice, which may be seen as such or may be revealed by the "nits" or eggs, little whitish bodies attached firmly to the hairs; for ringworm, scabbiness or scald-head, patchy baldness, wounds or scars, etc. The presence of

vermin is a cause of rejection in two ways, as indicating a lack of personal care, and as a danger to be introduced into crowded barracks. Superficial suppurative scalp diseases should generally cause rejection, as being contagious or as being caused by scratching excited by lice. Patchy baldness, if the patches are sharply defined and the skin is smooth, clean-looking, and not scarred, is apt to be harmless. If the skin is inflamed and scarred, and stumps of broken hairs are present, it should cause rejection. Irregular and incomplete baldness occurring in patches or tracts, giving at times a "moth-eaten" appearance, is most apt to be due to syphilis, and should cause careful examination for other signs of that disease.

Arms. The upper limbs should be examined as to their development and musculature, their free mobility in all joints and in all directions, the presence of all bones and joints, and a reasonable amount of dexterity and strength. Atrophy or wasting of a group of muscles or a part, inability to bend or make free use of a joint, and similar defects, should be carefully looked for, as they may otherwise be missed. Loss of one or more joints of a finger, swelling and deformity of a joint (baseball finger), or stiff contracted fingers are not uncommon, and, if in the fourth or fifth fingers, are not serious matters, though they should be noted. If in the second or third fingers, the matter is more serious, yet the applicant will usually be able to handle a gun and perform his other duties. Loss of a thumb is a serious defect, and in most instances would justify rejection. All deformities from badly united fractures or other causes should be noted, and should cause rejection unless the applicant can demonstrate his ability to execute the movements necessary in the performance of his duties.

Legs and feet. The legs should likewise be examined as to their development, musculature, size, mobility, etc. The applicant should be required to move all the joints, to jump, hop, and otherwise demonstrate his ability to use his limbs. Marked deformities, such as clubfoot, shortening of one leg, stiffness, marked swelling or marked limitation of motion in a knee or hip, should at once cause rejection. Less marked deformities, such as knock-knee, bow-legs, crooked shins, etc., need not cause rejection unless manifestly interfering with the free use of the limbs, or rendering the subject's appearance ludicrous or unmilitary. Here, again, marked wasting of a part or of a group of muscles will often be found due to a joint lesion, a paralysis or other nervous trouble, that would serve to disqualify the applicant. In addition to these defects, common to both arms and legs, the lower extremities are subject to other affections rarely or never seen in the upper.

Varicose or *dilated veins* are often seen. They usually show as swollen, bluish, and more or less tortuous vessels beneath the skin, and may be individually as large as a man's finger. They are most commonly seen on the lower legs, but are not very rare in the space behind the knee, and may extend up the inner side and front of the thigh to the groin. If marked, they should cause rejection. If only slight, and in otherwise desirable applicants, they may be passed, but should always be noted. At times they cause the appearance and persistence of very chronic ulcers, which occasionally bleed, pain, or otherwise disable the man. Such ulcers are especially apt to show on the front or to the inner side of the lower half of the leg. They are long in healing, are apt at any time to break open again, and when healed usually pre-

sent brownish, discolored scars. Such ulcers, or such scars if accompanied by varicose veins, should cause rejection. The legs are especially prone to *chronic ulcerations*, which may be caused by syphilis, tuberculosis, leprosy, and other infections. In general these are causes for rejection.

A rough, nodulated, tender shin-bone, is not an unusual sign of syphilis.

The *feet* require particularly careful examination, as on their integrity, usefulness, and strength (or what we might call their durability) depends a large part of the man's capacity for "soldiering." The best known and probably the least important of the foot-ills is corns. They are best known because most persons at some time have at least one, and they are one of the least important ills because in most instances they cause not even serious inconvenience, and they usually disappear with the use of properly fitting shoes and ordinarily good care of the feet.

If numerous and painful, however, or if soft corns, situated between the toes, they may justify rejection.

Sweating feet, which soften, blister, redden, and burn, may cause rejection, as they are not apt to stand much marching.

Stinking feet may justify rejection in most instances, as constituting a nuisance in barracks.

Bunion, an inflammatory and deforming joint-affection, usually at the base of the great toe, will, if very marked, disqualify.

Hammer-toe, a condition in which a toe is flexed and the end presses on the floor, while a knuckle projects above, is very apt to cause lameness and may justify rejection.

Overlapping toes may disqualify in a somewhat similar manner.

Deformities of the arch of the foot are very important. It may be too high, so that the weight is borne on the ball of the foot and the heel, the intermediate parts remaining clear of the ground. This is a relatively rare condition, but may disqualify. A common condition is the opposite, of *flat foot*, wherein the whole length and breadth or the foot touches the ground and the arch is almost or entirely obliterated. Such a foot in a white man is usually a poor marching foot, and, unless the applicant is a desirable man and states that he is a good walker, and that the foot never gives him trouble, it should cause rejection. When passed, its existence should always be noted, in case the man should be discharged for it later. The condition is more common but less important in negroes, but it may cause trouble in them also, particularly in the course of long marches.

Another type of weak foot is not really flattened, but tends to rotate outward, thus bringing the inner margin of the foot nearer to the ground and more directly under the weight of the body, where a greater weight comes upon it, causing it to tire and eventually to break down and become flat. It may justify rejection.

The draft examinations departed rather markedly from the peace-time requirements as to condition of the extremities, and the following disabilities were not sufficient to prevent unconditional acceptance of the recruit; recent injury of bone or joint with or without fracture or dislocation which the examiner considered only temporarily incapacitating, defects of bone or joint due to healed tuberculosis, if the tuberculosis had not shown activity for ten years; absent left thumb; a

low or absent longitudinal arch (flat foot); illnesses and disabilities which would not actually prevent the performance of full military duty. More considerable disability still permitted acceptance for special or limited duty.

Genitals. The genitals should be well-formed and normal. Both testicles should be present and in the scrotum; it should be possible for the applicant to retract his foreskin, and the penis should not show gross deformities, such as the opening of the urethra being placed far back from the end. Scars on the penis should prompt investigation as to their nature, whether syphilitic, chancroidal, or otherwise. The man should be required to express the contents, if any, from the urethra. Pus should at once cause rejection, as should any ulcers or sores on the penis, redness, puffiness, or signs of marked irritation about the urethra, or the presence of vermin, commonly known as crab-lice. Inflammation of the glans beneath the foreskin, and venereal warts, while not in themselves disabling, will often justify rejection as capable of exciting suppurative buboes, and as resulting from venereal disease or uncleanliness, or both.

Buboes are swollen and inflamed lymphatic glands, and are found in the groin. They may be single or multiple, on one or both sides, and may vary in size from that of a small cherry to that of an orange. While not all groin buboes are venereal, the great majority of them in applicants for enlistment are, and they justify rejection, even though the applicant insists, as he probably will if his venereal disease is not plainly evident, that they are due to " strain."

Varicocele is a condition of enlargement of the veins of the scrotum. It is most often found, and is apt to be

most marked, on the left side. The condition frequently causes no symptoms, though it is often said to cause pain, and is apt to be pleaded as an excuse from arduous duty. If present, it need not cause rejection unless very marked or unless the applicant says that it produces symptoms, but when passed it should always be noted, and the applicant be made to agree to be operated upon if symptoms begin, or if the condition comes to interfere at all with his duties.

Hydrocele is an enlargement of the scrotum, usually on one side, caused by an outpouring of clear fluid into the membranous sac surrounding the testicle. It produces a tense, painless, and often translucent swelling, which may at times be hard to distinguish from a tumor of the testicle or a hernia. Any one of the conditions, however, may suffice to exclude the applicant in time of peace.

While not much reliance can be placed on an applicant's denial of venereal disease and his assertions as to perfect genital health, he should be questioned on the subject, and should be asked as to the frequency of urination and his ability to pass a good stream of urine. Dribbling or inability to pass a good stream, or to hold or control his urine, should cause rejection.

The departure from peace-time standards in regard to genito-urinary and venereal diseases was very marked in the draft standards. Men were unconditionally accepted with uncomplicated gonorrhœa, syphilis with remediable manifestations, chancroids, buboes, gonorrhœal arthritis which was thought to be temporary in character, moderately movable kidney, albuminuria of temporary character, absence of testicles, acute cystitis of temporary character, phimosis, venereal

warts, amputations of the penis, hydrocele of moderate size, while still other lesions permitted acceptance for limited service.

Skin. The skin will necessarily be noticed and examined during the examination previously described. One of the first and most important points to be noted is its cleanliness. A dirty, foul, stinking skin usually indicates the type of man not wanted in our army, and it justifies rejection without further examination. Certain men, however, appear with their skins soiled with sweat and dust simply because of lack of opportunities for cleanliness, and if their general appearance and their stories indicate that they are desirable men, they should be given an opportunity to bathe and then be examined. It must not be forgotten that a filthy man may bathe for examination, but reveal his usual habits by his linen. However revealed, filthy habits should cause rejection.

A skin showing the marks of severe and generalized scratching is usually indicative of diseases or vermin infestation, and is therefore objectionable.

All forms of contagious skin diseases, such as ringworms and syphilitic eruptions, should cause rejection, or, in the person of an enlisted man, call for prompt treatment. As the line officer cannot be expected to differentiate such affections, he will be on the safe side if he treats them all as suspicious, though he should if possible learn to recognize acne, the common "pimply" eruption seen on the chests, backs, and faces, of many young men. It is usually not a severe affection, and as it may coexist with good health and good habits, it should not cause rejection.

The usual peace-time requirement of freedom from syphilitic and contagious eruptions, from itch and louse

infestations, were all departed from in examination of drafted men.

Character. While a few men who are not really physically fit get into the service, there are a good many more who are morally or mentally unfit, and they are the men who later spend much of their time in the guard-house or who swell the number of desertions. Against this class of men the recruiting officer works at a disadvantage. Unfortunately, almost any man, no matter what his character, can get letters of recommendation, so that such letters are really of little importance, and the officer is forced to rely largely on his own ability to judge men by appearances — a notoriously unsafe thing, and an almost impossible thing for some individuals. Some aid is obtained, though, by attention to the applicant's general bearing, his facial expression, his quickness of apprehension, the condition of his person and his clothing, and such evidences of alcoholism, venereal diseases, good habits, and truthfulness as the examination may bring out. When a man declares that he never drinks, although his breath is strong with alcohol at the time, or that he has never had venereal disease, though he shows a scar on his penis and another in his groin, or has a suppurative bubo that he says is due to a strain, the inference is fair that he is a liar and undesirable.

During the period of the draft army much assistance in eliminating the mentally inferior or diseased men was given by expert psychologists and psychiatrists, who also aided in classifying men for the service for which their mental endowments best fitted them. Ordinarily this must be done by medical and line officers, boards and courts, guided by the records and conduct of the men.

Under our system of voluntary enlistment, and as long as there are plenty of applicants, it is better to reject all those about whom the officer cannot feel well satisfied; and this whole chapter is based on such an assumed condition of affairs. In time of war, or when the supply of applicants for enlistment is not up to the demand, many men can be passed who would be excluded under our assumed conditions; but in all such cases they should only be passed by medical officers exercising great care, and every defect should be noted, both as to its presence and its degree, as constituting a possible ground of application for a pension.

The man being in the service and any defect coming to his commanding officer's attention, he should be referred to a medical officer to have it corrected if practicable, but at any rate to have it noted, in the interests of justice to the man and to the Government, and, if it be sufficiently serious, to have the man discharged before he breaks down in time of stress, with possibly serious results.

In this as in nearly all respects, the medical officer's duties can be performed more promptly and effectively if he has the coöperation of the line officer.

Official guidance in the examination of recruits, as well as a good comparison of standards for examination of a draft army in war-time and a volunteer army in time of peace, may be found in Special Regulations No. 65, of November 8, 1918, and the exceptions to it set forth in the letter from the Adjutant General, dated March 6, 1919.

CHAPTER II

PERSONAL HYGIENE

THE recruit having been accepted for the service in good health and good physical condition, it is his duty to himself and to his government to maintain those desirable conditions unchanged except for the better, if it be possible for him to do so. It will be possible in large part, if he is taught how to do it, and it is therefore incumbent upon his officers to teach him at least the rudiments of personal hygiene, and those rudiments may be summarized as follows:

Air. First of all he must be taught the importance of an abundance of fresh air both day and night, as a health-giving, strength-producing, and life-prolonging measure. He must know that "colds," sore-throat, pneumonia, and kindred troubles are not caused by cold air, but by micro-organisms; that those micro-organisms are much more numerous and much more apt to harm him in a warm, "close" room, with impure and rebreathed air, than in the open; and that such diseases are more common in cold weather, partly because in trying to exclude the cold man is apt to include such air. The habit of breathing deeply and thoroughly changing the air in the lungs is imparted to him by his gymnastic and military drills, and is helpful.

Rest. He should also learn early that his rest is important and should be taken regularly, in order to preserve his health and enable him, for that reason, to do without it more easily when the necessity arises. He

should get eight hours of sleep in each twenty-four, while four hours should be allowed for meals and short rests, changing of clothing, etc. In the remaining twelve hours he should do his work and his play. Regularity in rest and work is of great importance, and that is probably one reason that so many men improve rapidly in physique after entering military service. On the other hand, it is debilitating and demoralizing to steal the hours from sleep for drinking and venery. It is desirable that the night's rest be taken in clothing different from that used in the daytime, and the latter should be allowed to air. Every man should possess and use night-clothing, and the not uncommon habit of sleeping in the underclothing should be discouraged. No man should have a " barrack odor " clinging to him, and, if ventilation and clothing are looked after, he will not.

Exercise. The most beneficial exercise is that obtained incidentally to work or recreation. Exercise taken purely as such is usually repugnant, and takes on the aspect of work to men who feel that they already have an abundance of it. It should therefore be taken with some other incentive than is furnished by official orders. Baseball games, field sports, and other athletic competitions should be encouraged, and the effort should be made to interest and include all the men in them, and not merely a baseball nine and a few expert athletes in each post. The objects to be attained by exercise are the increase of the strength of the heart and the capacity of the lungs (on which two depend endurance), the increase of muscular strength, of nervous stability and control, of digestion and assimilation, and keeping the emunctories (the channels of waste excretion, such as the skin, kidneys, and bowels) active. No form of exer-

cise at present encouraged in the army fails to promote some of these ends, so they are all good.

Cleanliness. Cleanliness of person, clothing, and bedding, should and usually does, become a habit of life with the soldier; but some men require much watching and admonition to make it become so, and frequent inspections should be made in order that the admonition may not be wanting. In general, it may be stated that dirty soldiers are either recruits or men who through drink or vicious habits have suffered in their self-respect. Body lice are rarely seen in our service in time of peace, except in guard-houses, where they may be introduced by captured deserters or other prisoners. Bedbugs are occasionally found, and head-lice and itch infrequently. All of these pests should be carefully watched for and exterminated when found, as not only are they disgusting in themselves, and indicative of careless or filthy habits, but they may act at times as carriers of disease. Bedbugs, when once introduced in barracks, are at times very hard to dislodge, particularly if the buildings are old and show many cracks in the walls.

The responsibility of the individual soldier for his own cleanliness and freedom from vermin should always be emphasized. In time of campaign, and especially in trench warfare or winter hutments, when the facilities for bathing or for laundering clothing are poor or lacking, lice may spread widely through a command, and some regiments returning from France reached embarkation centers with a very large majority of their men lousy. As long as the commands depended upon central authority to get them deloused, progress was very slow and unsatisfactory. The supply of wash-boilers, soap, insecticides, and hand irons, and spread of the

information that men must free themselves from lice before being allowed to go home, resulted in prompt improvement of conditions.

Personal cleanliness should be understood as including the exclusive use of one's own linen and toilet articles. Disease may be transmitted readily by the indiscriminate or common use by several persons of the same towels, sponges, wash-cloths, combs, hair-brushes, shaving-brushes, etc. Some of the diseases which are most readily transmitted by these means are itch, ringworms and other skin diseases, granulated eyelids, gonorrhœal infection of the eyes, body vermin, and, occasionally, such infectious diseases as typhoid fever or smallpox.

It is not necessary that a man should bathe his body daily unless he is engaged in particularly arduous or dirty work, but he should bathe at least twice a week in summer and once a week in winter, and as much oftener as is necessary to keep his skin clean and free from all odor, especially from the feet, crotch, genitals, and armpits, and particular attention should be given to those parts. Once or twice a week, or oftener if necessary, the washable clothing — shirts, drawers, and socks — should be changed, and fresh put on. More frequent baths and changes do no harm, but should not ordinarily be demanded, except in the tropics.

The soldier cannot well give too much attention to his *feet*, as he thereby keeps them in good condition and directly increases his value as a soldier. Any trouble with them should at once be corrected by the man, by means of bathing, clean socks, properly fitting shoes, proper nail-trimming and cleaning; or, if of a kind not corrected by such means, it should be reported to the surgeon.

The *hands* are not subject to so many disabilities as the feet, but they should be kept clean and sound, the nails clean and trimmed, and it should become a matter of routine to wash them before taking food, as diseases so diverse as lead-poisoning and typhoid fever may result from the neglect of such a practice.

The *scalp* should not be neglected in the general cleaning, and its cleansing is facilitated by having the hair short.

Bedding should be aired and bed linen changed weekly.

Clothing. The clothing issued by the Government is nearly always of good quality, and is furnished in sufficient quantity to enable the soldier to be always comfortably, seasonably, neatly, and cleanly attired in a uniform and soldierly manner, and as much should always be demanded of him. He has to pay for his laundry-work, and he should have enough done to meet all the requirements indicated above.

Eating. The individual soldier has relatively little to do with the choice of his food, and the subject will be dealt with at greater length, in a later chapter. He has all to say, however, as to how he shall eat what is served to him, and he should be taught to avoid gluttony, to eat with an observance of the decencies, to chew his food thoroughly and eat slowly, to be as regular in his hours and habits of eating as his duties permit, and to avoid the use at meals of the enormous quantities of liquid, particularly coffee, in which he seems to find delight. A pint of water may be taken with a meal without harm, but a pint of coffee is apt to cause some disturbance, while a quart is much more apt to do so; and the fact that so little demonstrable harm does result

is probably due to the good general physique and surroundings of the soldier. Many soldiers, especially young ones, are prone to indulge at almost every opportunity in the eating of fruits and pastries, with less regard to the quality than to the quantity. This tendency is lessened by a good company mess, and it should be discouraged as apt to lead to digestive disturbances.

Regularity of the bowels should, if practicable, be established and maintained by regular habits, good food, the use of fruits and bulky foods, such as vegetables and oatmeal, and by exercise. Irritating or highly seasoned foods should be used sparingly, if at all.

The mouth. Among people of education and refinement cleanliness of the mouth is of course as much of a routine as cleanliness of face and hands, but persons whose education and rearing have been less carefully supervised are apt to neglect it, and recruits and occasionally soldiers from the latter class are at times seen with their mouths in a shameful state as the result of such neglect.

They should be taught (*a*) that such ailments as indigestion, toxic absorption, toothache, sore throat and sore mouth may result directly from such neglect, while many serious diseases are much aggravated by it, and (*b*) what will probably be more effective, that its existence is a mark of poor rearing and inferiority.

Every company commander should instruct his men somewhat as follows:

1. Every man should have a toothbrush, and should so use it at least twice daily, and preferably oftener, as to remove from the teeth and gums all particles of food or other foreign matter, brushing away from the gums and in all cracks and crevices.

2. That he should after each meal remove from between the teeth, with a wooden or quill toothpick, or with a thread, any pieces of meat or other food, and not allow it to remain and putrefy.
3. That he should promptly consult a dentist or a medical officer about any trouble arising in the teeth or gums. The medical officer can at least give him proper advice, and in many instances proper treatment. The services of a dentist are now available in nearly every large post.

Spitting and allied offenses. Much harm is done by careless spitting, urination, and defecation in improper places, by men ignorant of the harm they may thus do. Because apparently healthy themselves, it does not occur to them that they may, in answering a perfectly natural call, transmit disease to others. Yet, as will be shown in other places, they may be giving off the organisms causing typhoid or other infections in their urine or feces, or those causing diphtheria, tuberculosis, or other disease in their spit, and such organisms may then soak or wash into the water-supply, or may be carried as dust or mud to the mouths, hands, food, or breath of healthy persons, and so infect them. Decency and patriotism should prompt a man to show as much regard for the health of his comrades as for his own.

Sexual life. The question of venereal disease will be dealt with in a subsequent chapter. Much of it could be avoided if the ignorance and misconception regarding sexual life could be dissipated. Every man should know that sexual continence is compatible with perfect physical health, while its maintenance is far greater evidence of character and " manliness " than is the association with prostitutes, the abasement of virtuous girls, or the

lowering, self-respect-destroying and demoralizing practice of masturbation. The sexual organs and sexual desire are placed in man that he may procreate and replenish the race; but there is no physical penalty for his failure to do so, and the sperm necessary for the purpose will be discharged in sleep when it has accumulated sufficiently. "Wet dreams" and involuntary seminal emissions are not, therefore, necessary evidences of "loss of manhood" or of any other disorder, but are seen to be the natural and healthy method of disposal of the sperm not used in the legitimate sexual intercourse of married life. Every normal man has periods of sexual excitement and desire, which constitute one of Nature's powerful influences in the perpetuation of the race; but self-respect should prompt and self-command enforce a determination that such desire shall not lead to acts that violate the laws of religion and society. These periods of excitement and desire can be made less frequent, and continence promoted, by the avoidance of lasciviousness in speech, conduct, reading, and thoughts, by thorough cleanliness and otherwise complete neglect of the genitals, and by a regular, sober, active life.

Alcohol. The habitual and excessive use of alcohol is everywhere conceded to be harmful, while the moderate or judicious use of it excites much discussion, but has, in this country at least, fallen into disfavor. The recent enactment of laws prohibiting the manufacture and sale of intoxicants anywhere in the United States should simplify both the disciplinary and the hygienic problems of the army. Soldiers on foreign service, however, may have free access to liquors, and it is incumbent upon officers to teach them by precept and example that total abstinence is wise and beneficial under such cir-

cumstances as well as at home. The man who does not begin to drink before he is twenty-five years of age is much less apt to become a drunkard or a habitual user than he who begins before he is twenty, and there is a good chance that, if he abstains until the greater age, he will always do so. On the other hand, the impossibility of knowing who are, and who are not, capable of using alcohol judiciously should prevent our encouraging what we regard as judicious use in soldiers. Every military post used to show in its guard reports, its sick reports, and in unrecorded ways, the injury and loss of service resulting from excessive use of alcohol; so that it is not necessary either to quote military statistics or to go to civil life for the lesson. The inability to procure other liquor may lead men who are habituated to its use and crave it to drink flavoring extracts, perfumery, and wood alcohol. It is important to know that wood alcohol and its preparations are more poisonous than ordinary alcohol, and that death, or complete and permanent blindness, may follow their use.

Tobacco. Probably the least harmful and the most general of the so-called "bad habits" is the use of tobacco in one form or another. In our army the methods of using it are smoking and chewing. Of these chewing is probably the most objectionable as fouling the mouth and causing promiscuous spitting. Moderate smoking, indulged in after meals and in periods of relaxation, cannot be said to be very harmful, if at all so; but smoking in excess may do harm by causing digestive, respiratory, and nervous disturbances, among which may be heartburn, headache, palpitation or irregularity of the heart, insomnia, tremor, cough, and hoarseness. Just what constitutes excess may not be stated, as an amount

harmless to one man may be enough to cause injury to another. In general terms we may say that an amount causing any of the above-named or other symptoms in any man constitutes an excess for that man. As to the various methods of smoking, the same general principles apply. Cigar, pipe, and cigarette are equally harmless if not used to excess. The main objection to cigar-smoking is the expense; to pipe-smoking, the irritation of the mouth, in rare instances eventuating in cancer; and to cigarette-smoking, the habit of inhaling the smoke and thus exposing a much greater surface to the fumes, causing irritation of the vocal organs and the bronchial tubes, and the habit of rolling and smoking a cigarette at each opportunity, so that the total number consumed becomes excessive. The habit of smoking and the proper indulgence of the habit do the soldier so little harm and so greatly increase his comfort and contentment that they should not be interfered with. Stale tobacco-smoke in quarters, however, gives a very unpleasant odor, and the room should be daily opened and aired sufficiently to prevent or dissipate this.

Temperature and climate. There should be no necessity for telling men to dress properly for the season and the climate, but the necessity nevertheless exists, owing to the carelessness, ignorance, or perversity of men. It is neither profitable nor wise for an officer to undertake to prescribe just what his men shall wear at all times, as men differ in their capacity to stand heat and cold, and one man may be able to maintain the highest degree of health and comfort by never wearing flannel underclothing, while his neighbor may promote both by wearing it the year round, and the rest of the men in the squad-room by wearing flannel in winter and

cotton in summer. But men should be taught that exposure to either heat or cold lowers the resistance of the body and predisposes it to disease; that body-warmth is promoted by woolen clothing and that linen and cotton make cool clothing; that alcohol is not a fit substitute for an overcoat or a raincoat; that wet feet should be dried and dry coverings substituted for wet ones after marching or other exercise; that good intentions or thoughtlessness do not justify reckless exposure to extremes; and that it is their duty to the Government, as well as to themselves, to use discretion in dress and to try at all times to avoid sickness.

Exposure to strong sunlight is by some persons alleged to be the cause of some of the evils heretofore credited to the heat of the sun, and it is further stated that these effects may be obviated by the use of hat-linings and underclothing of black, red, or orange, to exclude the actinic rays. However, rather extensive observations and investigations made by various workers in the Philippines have afforded little or no support for such assertions.

In all climates and at all times the dress should be comfortable, and should hamper the movements, especially of the chest and abdomen, as little as possible. The equipment should be as light as circumstances will permit, should also be arranged with the idea of interfering with motion, particularly of the chest and abdomen, as little as possible, but should contain the necessary articles.

While the Government supplies the necessities of the soldier and supervises his hygiene to a considerable extent, it is seen already that the man himself is responsible for much, and there are a few more golden

rules that he should learn early for his own protection, and that will bear frequent emphasis and repetition, especially in campaign.

1. Be clean in person, clothing, and surroundings.
2. Eat no food but good food, and only with clean hands.
3. Drink no water from unauthorized or doubtful sources, unless it is boiled — plain, or in tea or coffee — or chlorinated.
4. Abhor, avoid, and destroy vermin, whether lice, fleas, ticks, flies, mosquitoes, roaches, mice, rats, or other varieties.

CHAPTER III

FOODS AND THEIR PREPARATION

IT is now trite and partly true that "an army travels on its belly," and plainly evident that the health and happiness of the individual soldier depend very greatly on what he puts into his belly. This is a matter largely in the control of the company commander, and it is therefore important that he should have some knowledge of foods and their preparation, and should pay great attention to mess-administration. Many company commanders do so, but others, knowing little of the subject, delegate the entire matter to their mess-sergeants, who may know less, and the men suffer. The Government ration and the regulations concerning its use are very liberal, and if a company does not have an abundance of good, nutritious, and attractive food, the fault is nearly always in its handling after it reaches the company.

Classes. Foods are of different classes, and a judicious and proper mixture of these is necessary for the maintenance of health and strength.

Proteids, or albuminous foods, are the class represented by the white of egg or lean beef. They occur also in vegetables, beans and peas being particularly rich in proteid, and this fact makes an exclusively vegetarian diet a health-sustaining possibility, which a proteid free diet is not. Animal proteid is more easily and completely digested than that from vegetables, and to most persons is also more agreeable. An exclusive meat diet

can maintain health and strength for long periods of time, and careful observations on the Eskimos of Disco Island in Western Greenland show that they maintain excellent health and nutrition on a diet almost exclusively of meat. "The physical endurance of Eskimos nourished in this way is conspicuous, as is their resistance to the rigors of the climate."

Fats are the class of food represented by the fatty tissues of animal bodies and the various vegetable oils. They are very valuable as foods, owing to their great fuel-value and the amount of nutriment contained in a small bulk; but if taken in excess they are difficult of digestion and cause dyspepsia and diarrhœa. They are especially valuable in cold climates, a fact which we recognize in our practice of eating pork and other fat foods more freely in winter.

Carbohydrates are the sugars and starches, represented by cane-sugar, fruit-sugar, and others, and by starchy vegetables such as potatoes and grains. For practical purposes we may say that the carbohydrates are of vegetable origin. Cellulose, as found in the husk and fiber of plants, is another form of carbohydrate, having a food-value for herbivorous animals but none for man. The carbohydrates have about the same fuel-value, weight for weight, as the proteids, and less than that of the fats. Starches may be taken in large amounts, but sugar, if taken in excess or in too concentrated a form, causes dyspepsia and other disorders.

Inorganic salts, as represented by common salt and other salts contained in foods, have no fuel-value, but are necessary in maintaining the nutrition of the body, and the same is true in even greater degree of *water*.

Organic acids, flavors, and *condiments*, as found in

fruits, many vegetables, and in spices, are of value secondary to the preceding classes.

There is another class of substances that are not carbohydrate, proteid, nor fat, that occur in very minute quantities in foods, the existence of which has been known for only a short time, yet they are very important and their absence from the diet results in disease or death.

These substances are spoken of as *vitamines* and it is fairly certain that there are at least three of them:

(1) A principle, contained especially in the seeds of plants and the eggs of animals, which is soluble in alcohol and water and which is necessary for the prevention of beri-beri in man and a similar neuritis in some animals and birds. Highly cellular organs, such as liver and brain, contain considerable amounts of it. Yeast cells are a rich source. In peas, beans, and pulses this vitamine is distributed throughout the seed, but in cereals it is concentrated in the germ and in the outside layer (bran) which are removed in milling.

Beri-beri is occasioned by a too exclusive diet of cereals from which the germ and outside layers have been removed by milling. It is particularly apt to occur in tropical peoples whose diet consists mainly of rice, unless the rice is "undermilled" so as to leave a part of the germ or the outer layer. It is known to occur in people living almost exclusively on white wheat-flour. It is not known where rye bread is the staple food, because the germ of rye is not removed in milling.

(2) A fat-soluble factor which is necessary for the promotion of growth and for the prevention of rickets in many young animals. This also appears essential for the maintenance of health in adults, and it is quite

possible that the "war œdema" which occurred in Germany and Austria during the World War was due mainly to the lack of it. The main sources of this vitamine are certain fats of animal origin and green leaves of plants. It occurs most abundantly in cream, butter, beef-fat, fish oils (especially cod-liver oil), and egg yolk. It is present in very slight and neglible amounts in lard and in vegetable oils. As stated, green leaves contain it, but root vegetables are deficient in it.

Its absence from the diet will cause the development of rickets in babies or puppies.

(3) A substance which is necessary for the prevention of scurvy and which is found in fresh vegetable and fresh animal tissues. It occurs abundantly in fresh cabbage, rutabagas, turnips, lettuce, lemons, oranges, raspberries, and tomatoes; less so in potatoes, carrots, green beans, beets, and limes. Drying reduces the amount of it in fruits. Dried or canned meats and vegetables are usually wholly deficient in it. Dried peas and grains do not contain it, but sprouts coming from them do.

Infants nursed at the breast or fed on raw milk do not have infantile scurvy. Fed on boiled or canned milk they are liable to it unless also given orange juice, meat juice, or other antiscorbutics.

Amount of food. For many years Voit's standard was taken as representing the approximate amounts of the three main classes of foods necessary each twenty-four hours for the maintenance of health and vigor in the average working adult.

According to that standard the requirement was 118 grams of dried proteid, equaling about one ration of beef, 56 grams of fat, and 500 grams of carbohydrate,

that is, of starch and sugar. The total value of this diet was over 3000 calories.

More recently, Professor Chittenden, of Yale University has shown that health, strength, and vigor can be maintained by many individuals on half the amount of proteid, without any increase in the fats or carbohydrates.

The recent World War caused such shortage of food in many European countries, especially in Russia, Austria, the Balkan States, and Germany, that great numbers of people suffered and many died. The German official ration for civilians was in many places reduced to a value of 1400 calories and much of what was allowed was in food forms poorly utilizable by human beings. *War œdema* and other manifestations not recently familiar resulted from this shortage. It is probable that German observations on the effect of underfeeding, and especially on that of shortage of fats, will prove of great interest and value. At present we know that shortage of fats was keenly felt.

Meats are mixtures of proteids and fats, and contain water and salts also. They vary in palatability, cost, digestibility, and nutritive value; but all meats have nutritive value, though if diseased or decomposed they are not available for use.

In our service *beef* is the standard meat for issue, mutton, pork, fowl, and fish being substitutes issued only occasionally; and, considering the cost, nutritive value, palatability, digestibility, tolerance, etc., it is the most valuable meat.

Mutton is almost equally valuable for nutrition, but many persons dislike the taste of it, and almost all tire of it sooner than of beef.

Pork is fatter than either beef or mutton, and is therefore much more used in cold than in warm weather. It is more difficult of digestion than beef and not so generally liked, though bacon is much used in the army and is a popular and valuable food, especially in the field.

Veal is seldom issued to troops. Its nutritive value is somewhat less than that of beef, and it causes diarrhœa in some persons.

Fowl, as chicken or turkey, constitutes a special treat on national holidays and festal occasions. If freshly killed and healthy fowls are served, it is valuable as well as appetizing food; but when birds long kept undrawn in cold storage are issued, as is not infrequently the case, their quality should be suspected and each bird carefully scrutinized, and, if of doubtful appearance or odor, rejected.

Fish vary greatly in palatability and nutritive value, but all of them keep poorly, especially if allowed to die slowly and if not packed in ice or frozen. The meat should feel firm to the touch, and not crush on gentle pressure. Dried and canned fish, as issued, are practically always good, but they are not suitable for frequent or prolonged use, as men very soon tire of them.

Eggs consist of animal proteid and fat, and are classed with the meats. They are nutritious and usually easy of digestion. They may be cooked in a great variety of ways as a main dish, and are very frequently used in other dishes, such as puddings and cakes.

All meats should be eaten cooked, as proper cooking improves the flavor, increases digestibility, and destroys parasites that might otherwise cause disease in the eater. Among the disease-producing organisms which

may be conveyed by meats but which can be destroyed by heat are:

1. *Tapeworms* of various kinds, the three most common ones being transmitted respectively by beef, pork, and fish, the meat in either case being "measly."
2. *Trichina*, a species of larval worm which infests the muscles, causing great suffering, and, at times, death. It is conveyed to man by eating underdone pork that contains the parasites.
3. *Tubercle bacilli*, the cause of tuberculosis.
4. *Bacteria causing some animal diseases*, which may reproduce the same diseases in man, or may merely cause intestinal trouble. Paratyphoid, a disease resembling typhoid, may be so produced, as may many so-called "acute food poisonings."
5. *Ray fungus*, the cause of actinomycosis or lumpy jaw in cattle.
6. *Typhoid bacillus*, the cause of typhoid fever, may be conveyed in oysters or other shellfish coming from polluted waters.
7. The *bacillus of anthrax*, the cause of a very fatal disease.
8. The *bacillus* causing "*trembles*" in cattle and "*milk sickness*" in man.

Some diseases fatal to food animals do not affect man, and the flesh of animals dead of such diseases can safely be eaten; but in general it is safe and wise to avoid all such meat, as, though the disease killing the animal may not affect man, chemical changes may have occurred in it to give rise to poisons, and ptomaine poisoning or "meat poisoning" may result. *Ptomaine poisoning* may also result from the action of bacteria contam-

inating the meat after death, or even after cooking, and causing changes in it. Such instances are seen when poisoning occurs from cold meat or hash cooked some days before use, or from canned meat taken from imperfect tins. When the ptomaine or other poisonous products of bacterial action are once formed in the meat, they often may not be destroyed by cooking, and all such meats are dangerous.

Some few kinds of meat, principally fish, are poisonous in themselves, and may cause death.

Meats are preserved for use in a variety of ways, only a small percentage of those furnished the army being used so soon after killing as not to require some form of artificial preservation. Of these methods of preserving, *cold* is the most satisfactory and best keeps the meat unchanged, and by this means it may be kept for months. It is applied so as to freeze or merely to " chill " the meat, and its only effects are to render the flesh more tender and to detract somewhat from its flavor, particularly by causing an unpleasant change in the taste of the fat. Frozen meat may be kept indefinitely, but that which is merely chilled does deteriorate in time, becoming soft, slippery, and flavorless. It should not then be used as food. Cold cannot be depended upon to destroy the germs or parasites in meat, though keeping for a long time will destroy some of them.

Salting, pickling, and *smoking* are much used in preserving meats, particularly beef and pork, and the results are very good. Ham, bacon, and corned or smoked beef are excellent and palatable meats for occasional use, but they are not adapted to long use to the exclusion of fresh meats, and when they are so used the health is apt to suffer. These processes tend to

free the meats from parasites, but cannot be depended upon to do so, and the eating of raw ham is dangerous.

Canning, with its attendant sterilization of the meat, preserves all of its nutriment and destroys most bacteria and all animal parasites, but it melts the fat, gelatinizes the gristle, and softens the muscle, so that the meat comes from the can less attractive to eye or palate, but it is good and valuable.

Preservation by means of drugs and chemicals, other than those used in pickling or salting, such as boric acid or formalin, is forbidden, and meat so preserved may cause sickness; but for emergencies and occasional use it would not ordinarily do so.

It is not desirable here to consider in detail the various methods of cooking meats, but the company officer should exercise a certain amount of supervision in the matter, to see that his men's digestion is not injured by an excessive use of fried meats, that their appetites are not impaired by poorly prepared or poorly served roasts, stews, and hashes. A company mess is often good or bad as the cook knows, or does not know, how to handle, prepare, utilize, and serve meats. Rather common faults in company cooks are as follows:

Roast or baked meat is overcooked and dry, is taken from the oven an hour or two hours before meal-time and sliced, and is served with hot, greasy gravy to make it warm.

Tough ends, scraps, and bones are not utilized in making soup stock, as they should be.

Excessive fat is not rendered and utilized.

Hashes and stews are served with unnecessary frequency, and become monotonous.

Lack of imagination or lack of knowledge on the

part of the cook and mess-sergeant result in lack of variety and attractiveness of the mess. Intelligent supervision of the mess by the company commander, the preparation of bills of fare in advance, so as to insure variety, and the study of good cook-books will obviate this.

Bread. The principle carbohydrate food is bread, and its importance in the mess is scarcely, if at all, secondary to that of meat. The ordinary supply of bread is issued as such, and its quality depends largely on the capacity of the post baker, notwithstanding his proneness to credit any defects in it to the flour, the yeast, the hops, or the oven. The materials supplied by the Government are, with rare exceptions, excellent, and the failure to produce good bread is usually to be attributed to either the ignorance, the carelessness, or the uncleanliness of the baker. With the proper training of the bakers such failures will seldom be seen. This has been accomplished in part and army baking is much better than in former years. Company cooks are permitted, and should be encouraged, to make *biscuit* and *muffins* occasionally. They are somewhat more difficult of digestion than good issue bread, but are much liked and add to the attractiveness of the mess. Stale bread (that is, more than twenty-four hours old) is somewhat more digestible than fresh or hot bread; but during the process of staling it should be kept covered and protected from dust, and should not be unnecessarily handled, nor by any but clean hands; otherwise bacteria and moulds find lodgment and growth upon it and may produce disease. Toasting improves some breads and adds to their digestibility, but it is not often done in companies.

Pastries and *cake* are also bread, but are less easily

digestible than the ordinary forms. They add much to the attractiveness of a mess and should be served occasionally. The same remarks apply to the various kinds of batter-cakes.

Cornbread also makes a pleasant change from the monotony of baker's bread, and, as it is cheap, palatable, and nourishing, its use is to be encouraged.

Corn-meal mush, with butter or milk, is also relished, and when cold may be sliced and fried.

Hard bread is issued only for field use. Good teeth are necessary for its utilization as issued, but it may be softened in hot water or coffee without impairing its value.

A measure of economy, sometimes ignored, is the utilization of crusts and fragments of stale bread in puddings, as meat-stuffing, and in other ways. Such practices add to the variety and attractiveness of the mess, and allow savings to be made in other directions. To throw away such crusts because sugar and eggs are necessary in puddings and cost a little extra, is wasteful and wrong.

Vegetables supply all classes of foods, and are very important in the soldier's mess for this reason, and because they serve to impart variety and attractiveness to it. The most important vegetable issued (except wheat) is the *potato*, which consists of almost pure starch. It may be cooked in a much greater variety of ways than is usual in most companies, and the company commander should see that such is the case. In whatever way they are prepared, potatoes should be cooked until soft or mealy, and should be served hot.

Rice is another valuable starchy food, and in some parts of the world it is the main article of diet; but in

our country it is much less used and less desired than bread or potatoes. It is most popular with soldiers as a pudding, though it may be prepared in a variety of ways. It should be used to give variety and served in attractive forms, cooked with tomatoes or something else to take away its insipidity. Undermilled rice has a flavor superior to that of the highly milled and is also preferable, especially when used as a main article of diet, because of its content of vitamines, which are lacking from the latter.

Corn is also to be classed as a starchy food. Ripe corn in the whole or the broken grain, as hominy or grits, is not so generally liked as the green, but it is very nutritious, and should be used occasionally as a principal dish.

Macaroni and other paste preparations are valuable foods, and admit of a variety of presentations, so that their use should be encouraged.

Onions are a staple article of issue, and are much used in the army. Their nutritive value is much less than that of the articles just discussed, but their flavor and the variety of ways in which they may be used make them very valuable. Monotony should be avoided in their use.

Tomatoes, likewise, have relatively little food-value, but stand high for their flavor and the variety they afford. When they are served cooked, it should often be with some otherwise insipid food, such as rice, macaroni, or stale bread.

Beans and *peas*, though possessing considerable starch, are the principal sources of vegetable proteid. They are both very attractive and palatable in the green state, and, though less nutritious than when ripe, add much

to the mess. When dried, they are particularly valuable in making soup (for use in which ham-bones and rinds should always be saved), and when served boiled or baked, with bacon.

Beets are another valuable source of food, as they contain much sugar. They are also cheap, and are relished by most men.

Most of the common vegetables, as cabbage, greens, carrots, spinach, radishes, and cucumbers, have little nutritive value, but they add greatly to the attractiveness of the mess and are also valuable in preserving health and preventing scurvy, and their use should be encouraged.

Their lack and the consequent occurrence of scurvy are apt to be matters of vital importance in sieges.

Salads are not used in company messes as much as they should be. They afford pleasing variety, and may be made to constitute an important dish, as when composed principally of potatoes or salmon.

Desserts. As issued in company messes, desserts are nearly always very simple, and such is necessarily the case. When practicable, a dessert should be furnished once a day, and it may be made to use up otherwise unattractive articles, such as rice or stale bread made into puddings. Pies made of fresh or dried fruits are easy to make and serve, are inexpensive, and well liked.

Milk and its products constitute important articles of food, though not entering so largely into the soldier's dietary as they might. Milk contains all classes of food — proteid, fat, carbohydrate, water, and salts — though not in the proportions desirable in maintaining adult life. Fresh milk is both more palatable and more wholesome than the canned or condensed article, if its purity

and freedom from disease-producing germs can be assured, but unfortunately this is not always the case. It should be borne in mind that many serious diseases may be conveyed in milk, among them tuberculosis, typhoid fever, dysentery, diphtheria, septic sore throat, and scarlet fever — some of the diseases most dreaded in military life. Milk sickness, a disease now rarely seen, was also conveyed in that way; while for many years the Mediterranean garrisons of the British army suffered very seriously from Malta fever, now known to have been transmitted by means of goats' milk.

In case of epidemic of any of the above-named diseases, the milk supply should be investigated, and this is particularly suggested by outbreaks of typhoid showing an explosive character, that is, epidemics in which many cases occur almost simultaneously. Because of this possibility of disease-production, milk whose origin and condition are not above reproach should be used in companies and post exchanges only in cooking or after boiling, and in camp or on the march men should be cautioned to the same effect, and warned against purchasing it by the glass from dealers or peddlers. Condensed or evaporated milk is more generally used in companies than the fresh article, and it is on the whole probably safer, as the process of condensation and the subsequent prolonged storage tend to destroy disease-producing organisms. A can of such milk, when once opened, should either be used promptly or kept cool and protected from dust until used. Boiling water should be used to dilute it, to kill germs that may have settled and grown on it after the opening of the can.

Buttermilk is a valuable and pleasant drink, and where it can be obtained is much relished by the men.

Good *butter* is made from good cream and is everywhere highly appreciated; but unfortunately the good quality is not always obtainable, and much very poor butter is used in company messes. Oleomargarine is little inferior to butter in nutritive qualities and is to be preferred to poor butter. It has an advantage over butter in that it is not so likely to act as a carrier of disease germs.

Both are valuable fat foods as well as relishes, and should not be regarded merely in the latter light.

Cheeses are very concentrated forms of food, containing about one third proteid and one third fat, though the different varieties differ in the percentages of these. They make agreeable and valuable additions to the mess, but are seldom used in large quantities because they are apt to be difficult to digest, and to cause constipation. Ordinarily they are used in companies rather as a condiment than for their food-values, though at times they may constitute an important part of a meal. In cooking, cheese is used principally with macaroni. Milk and cheese are liable to certain changes, which cause the development of poisons, one of these, known as tyrotoxicon, being very powerful and producing severe symptoms or death. The ordinary souring of milk is not in itself dangerous, but may be beneficial in some respects. The justification for regarding sour milk with suspicion lies in the fact that the conditions favoring the development of the bacteria causing the souring may also have favored the development of disease-producing organisms. Milk should be preserved either by refrigeration, to prevent the growth, or by heating, to kill the contained bacteria.

Canned foods. For preserving other foods than meats

and milk, refrigeration, canning, and drying are the three great commercial methods. Cold storage may preserve fruits and vegetables, as well as meats, eggs, and milk, practically unchanged for weeks, and immense quantities are so preserved and sold. Of even greater importance, however, is the process of canning, whereby the articles are cooked, sterilized, and hermetically sealed in cans or jars, to be preserved for months or years. This industry has increased enormously, and is now applied to almost all of the articles of food that have been discussed herein, and to a great number of others not so discussed.

The results obtained are excellent, and such foods are carried to all parts of the world and enjoyed.

Canned foods pall after a time, though, and should never, if it can be avoided, be used to the exclusion of fresh food. Otherwise nutrition may be impaired, and even scurvy may result. This may be because the heat necessary to preserve them destroys the vitamine that prevents scurvy. The fear of metallic poisoning from canned foods is thought to be exaggerated, and the probability of such poisoning to be remote, except where lead is used, and that is infrequent and does not apply to the great bulk of canned foods used by the soldier.

Drying as a method of preservation is applied to fruits and vegetables, as well as to meats and fish. Desiccated vegetables find some use in the army, particularly in Alaska, where they constitute a real blessing, but their use is not general.

Dried fruits, however, are everywhere used and with very general satisfaction. Dried apples, peaches, prunes, and raisins, are issued or sold by the Supply Department, and make valuable and pleasing additions to the

mess, where they are served stewed or in puddings and other desserts.

Sweets are much enjoyed by the men, and are valuable for their fuel-value, and also, probably, as lessening a craving for alcohol. Syrup and jam are articles of the ration that are much enjoyed, while the sale of candy by the Supply Department shows that its worth is recognized. As stated before, an excess of sugar causes dyspepsia and should be guarded against.

Beverages. Coffee, tea, and cocoa are mild stimulants, but may almost as well be classed with condiments. Of the three, coffee is the only one extensively used in our service, and it is often poorly made and poorly served. The green issue coffee is of excellent grade, and if properly roasted and ground, and used fresh, is superior to most higher priced coffees obtained elsewhere ready roasted. The preparation of good coffee is simple and easy, but most company cooks do not practice it. The company commanders should make sure that, in addition to proper steps in preparation, the following are observed:

The coffee must not be long boiled.

The coffee-pot must be emptied and cleaned after each meal, and no coffee grounds should be used twice,

The sugar and milk, if the latter be served, should be put in by the user and not served alike to all.

Enough coffee should be used to give strength and flavor to the beverage, and then but a moderate amount of it should be served to each man.

In the field, where the water is of a doubtful character, the issue of large amounts of weak coffee is justified, as tending to reduce the amount of unboiled water used; but in posts this is not necessary.

Cooks sometimes insist that the men prefer their coffee weak, long-boiled, and ready sweetened, just as they will say that they prefer roast beef overcooked, dry, and swimming in greasy gravy; but inasmuch as most men in civil life like to exercise a choice in such matters, it is thought that a like privilege might be appreciated in the service.

It is also thought that perhaps the use of tea in the service might become more general if the beverage were properly made, and not boiled or steeped until a strong, black tannin solution results.

The following is a bill of fare for one week, which, it has been demonstrated, can be supplied with little extra cost beyond the savings on the ration, provided that the cook is capable and careful and the mess-sergeant intelligent. Slight variations from week to week and to suit the seasons will permit such a bill of fare to be used for a long period and give satisfaction.

Monday

Breakfast: Stewed fruit, fried eggs, bacon, bread, and coffee.

Dinner: Roast beef, steak, or meat balls; baked potatoes; squash or turnips, stewed tomatoes; pie or cake.

Supper: Cold sliced beef, fried onions or tomatoes, bread and jam, tea or coffee.

Tuesday

Breakfast: Bananas or fresh fruit, liver or kidney with bacon, bread, butter, and coffee.

Dinner: Beef steak, or Hamburger steak; potatoes, radishes, or onions; pudding, bread, and coffee.

Supper: Cold beef, fried potatoes, bread and jam, tea or coffee.

Wednesday

Breakfast: Stewed fruit, fried mush and molasses, coffee.

Dinner: Boiled ham; boiled potatoes, boiled cabbage; pudding, bread, and coffee.

Supper: Cold boiled ham, bread and jam, butter, tea or coffee.

Thursday

Breakfast: Stewed fruit, puffed rice, wet hash on toast.

Dinner: Roast beef, steak, or meat balls; baked potatoes, corn, squash, or turnips; pudding, bread, and coffee.

Supper: Cold beef or hash, bread and jam, fried onions or tomatoes, tea or coffee.

Friday

Breakfast: Stewed fruit, oatmeal with milk, biscuits with syrup and coffee.

Dinner: Baked fish with sauce; boiled potatoes and onions; bread, butter, and coffee.

Supper: Salmon or other fish salad, bread and jam, tea or coffee.

Saturday

Breakfast: Stewed fruit, bacon, rice or corn flakes, toast, and coffee.

Dinner: Baked beans with pork; pickles, stewed tomatoes; bread and coffee.

Supper: Cold beans or bean soup, pickles, tomato catsup, bread, butter, and coffee.

Sunday

Breakfast: Stewed fruit, oatmeal with milk, hot biscuits, coffee.

Dinner: Roast pork, veal, or mutton; browned potatoes, baked squash; apple sauce, pie or cake.

Supper: Cold meat, bread and jam, tea or coffee.

These menus are merely samples and can be improved upon. Now that there is less strict adherence to

the old ration allowance than was formerly the case, reduction of meat and increase of vegetables would often be beneficial and economical.

THE HYGIENE OF THE KITCHEN

From the hygienic and many other points of view the company kitchen is one of the most important places in the post, and the company cook a very important person.

These two bear a more direct relation to the guard reports, sick reports, and the general efficiency of the command than at first appears; while the subjects of alcoholism and desertion are especially involved.

It is therefore an important part of the company commander's duties to see that both are as good as can be obtained. He should see, as stated before, that his cook is capable of preparing the food in attractive, satisfying, and digestible forms, that he is economical, a good manager, and can utilize the ration in a variety of ways and supplement it judiciously. But the cook may fulfill these requirements and still do much harm by causing or spreading disease. Therefore he and his company officers should know something of the hygiene of the kitchen.

Cook. The primary and most important rule as to cook, kitchen, and the contents and surroundings of the latter, is cleanliness. All parts of the barracks and all persons therein should be clean, but the kitchen and the cook should excel. The cook should bathe often, change his clothing frequently, always wash his hands after a visit to the toilet, after handling anything dirty, and before handling foods. He should always have a clean hand-towel in his kitchen, and not use for the purpose

either a dirty rag or his dish-towels. He should wear white aprons, caps, and clothing, and change them when soiled. His finger-nails and his hair should be kept short and clean, and a nail-brush should be in the kitchen for use and should be scalded daily. A cook who has had typhoid fever, or, rarely, one who does not know that he has had it, may, though apparently in good health, be excreting and distributing typhoid bacilli; and a typhoid epidemic limited to a company should always cause this possibility to be investigated. Men who are dirty in their habits, who have syphilis, tuberculosis, or other infectious diseases, or who are persistent in unsanitary or careless methods of preparing foods, should not be allowed to cook.

The kitchen should be proof against the most rigid inspection for dirt. Some disorder and litter necessarily attend the preparation of food; but this can usually be cleared up almost immediately, and it should not remain any longer than necessary. The meat-block, bread-boards, carving-tables, and all utensils should all be inspected daily and all kept clean.

The ice-chest and milk-cans should receive special scrutiny, and should be clean inside and out, as evidenced to the eye, the nose, and the white glove.

Foods like cheese, codfish, and bacon, that possess a strong odor and do not readily spoil, should be kept on shelves or in boxes, protected by wire gauze, rather than in the ice-chest. Canned meats, fruit, and vegetables should be used as soon as possible after they are opened, or emptied into clean dishes, and not left about in the cans. All food should be used before it becomes mouldy, sour, or decomposed, or should be thrown away, though a slight and recent growth of mould on the surface of

ham, cold-storage beef, bread, jam or other sweets does not necessarily injure the whole, and may be removed.

The kitchen sinks should always be kept clean, and should be well trapped. Care should be exercised that grease, crumbs, and fragments are kept out of them, that the pipes may not become clogged. Kitchen waste, the scrapings of food from plates, and unused fragments should be thrown into covered cans, which should be emptied and cleaned once daily, and should not serve either as a breeding or a feeding place for flies, roaches, rats, or other vermin. Particular care should be exercised to exclude all such from the kitchen at all times. For this purpose cleanliness and screens should suffice, but if fly-paper, roach-poison, and rat-traps are needed, they should be supplied.

The *kitchen police* is usually supplied by roster from the company, but at times the work is given as a punishment. This is undesirable. Instead of poor men, good ones should be put on kitchen police, and the work should carry with it immunities and privileges to make good men desire it.

Men who are sick should be excluded from duty in the kitchen. In 1909 the writer investigated an epidemic of typhoid in a battery of mountain artillery at Fort D. A. Russell, and found that its spread was due to the fact that certain men were on duty as kitchen helpers at the time when they were in the early days of typhoid attacks. They infected their comrades by handling food that these ate.

Note. Every mess officer should possess and study the MESS OFFICER'S MANUAL prepared by Officers of the Division of Food and Nutrition of the Medical Department, U.S. Army, and published by Lea and Febiger, Philadelphia and New York, 1919.

CHAPTER IV

THE HYGIENE OF THE BARRACKS

NEITHER the enlisted man nor his immediate commander has very much choice in the matter of barracks. They are assigned to duty at a post where certain barracks are provided, and must of necessity make use of them. In one post the barracks may be new, large, and built with a view of affording all possible advantages in the way of comfort, convenience, and sanitary arrangements. In another post they may be old, small, and apparently built without a thought of any of the advantages mentioned. In the one the capacity of the barracks may greatly exceed the size of the garrison, in the other, the reverse may obtain; but in nearly all instances the conditions are controlled by military necessity and not by the company commanders. It is therefore considered that the proper scope of this chapter is to indicate what is desirable, and to assist in making the nearest practicable approach to it under existing conditions.

Buildings. The buildings are apt to be of almost any material, from brick, stone, or concrete, to nipa and thatch. Usually they are of substantial materials and well constructed, unless designed for merely temporary use in warm countries, when light board structures or those of bamboo and palm are used. In the latter class, cheapness of cost is always a consideration; but it is not to be carried to the extent of making the structures unsanitary. Sufficient room should be provided, ade-

quate and convenient supplies of good water, proper kitchen arrangements, and protection from mosquitoes, flies, and other insect pests. The structures should be sufficiently raised above the ground to prevent dampness, if possible, and ample provision should be made for the care of excreta, garbage, and waste water.

In permanent barracks of the newer type, provision has usually been made for the sanitary requirements, and the conditions are satisfactory where overcrowding does not obtain. Barracks of concrete, stone, brick, or wood may all be satisfactory if other considerations are met. One of the first of these is location and exposure, and the desirable locations and facings vary with climate and local conditions.

In general, it is well to get much exposure to the sun in cold climates, and this is best accomplished by having the four corners of the main building point in the cardinal directions. In such places, however, the avoidance of prevailing winter winds may be of even greater importance, and may dictate a location. In any event, both sun and wind must be considered in their sanitary as well as their comfort-bearing capacities, the former as a great aid in cleanliness and disinfection, the latter as a promoter of ventilation. In any climate, the structures should be dry as to both site and walls. Damp cellars and surroundings may be avoided by selection or by grading and drainage. Damp walls are avoided by having a damp-proof course, as of slate or concrete, above the foundations, by double walls with air-spaces, by good ventilation, and, where excessive or hard-driven rains obtain, by waterproofing with paint, etc. If the walls are continuously of porous brick or stone to the cellar, or to the surface of the

ground, they will be continuously damp and chilly, in most climates, and only the insertion of a damp-proof course will correct the condition. If other considerations, such as size, ventilation, heating, or plumbing, are unequal, they should be allowed more weight, in governing the choice of barracks, than the structural material; if all other considerations are equal, the structural feature should govern choice, usually in the following order: concrete, brick, stone, wood.

Rooms. The buildings should be sufficiently large to provide abundant squad room, recreation or day rooms, store-rooms, kitchen, pantry, and dining-rooms, small rooms for non-commissioned officers, tailor's, barber's, and cobbler's shops, a workshop for the mechanics, and ample water-closet and bathing facilities, unless a part of these are provided elsewhere.

The *squad-rooms* are the matter of greatest consideration, and they should be given first thought in selecting barracks. They should always be as large as it is possible to obtain, keep clean, and heat, and should provide a minimum of six hundred cubic feet of space and sixty square feet of floor room for each man, exclusive of the room occupied by wardrobes and lockers. Our experience with respiratory diseases in camps of mobilization and in France should prevent forever, if it be at all possible, such overcrowding as occurred there. There were 45,048 deaths from disease in the army from September 1, 1917, to January 31, 1919. Of these ninety-two per cent were due to diseases of the respiratory group. The two special factors making for the great prevalence and mortality of these diseases were the introduction of great numbers of unseasoned and susceptible young men and their exposure through close contact with sick

men. The small amount of twenty square feet of floor space per man was actually prescribed as allowable in the A.E.F. That the forces there did not fare so badly as at home was probably due to the fact that the men were more seasoned, the most susceptible having been eliminated by disease in home camps, to milder climatic conditions, and to the fact that many men were billeted in houses where the exposure to infected crowds was less than in large barrack rooms.

These experiences indicate that, in addition to ample allowance of floor space, it would be wise to divide large rooms into walled compartments for six or eight men each, while the barracks of recruit depots should be divided into cubicles or stalls for individual men. Another good arrangement would be to have each bunk separated from those on either side of it by a screen of composition board or some similar material. A useful means of improvising such screen separation is to have each man suspend his shelter half at the right side of his bunk, so that it extends two feet or more above his head when he is lying down. Double tiers of bunks are desirable as increasing lateral separation, provided that the floor space per man be not reduced.

All squad-rooms should be well lighted both by windows and artificial light, preferably electric. The window space necessary will vary with climate and location, but it should insure plenty of breeze in the tropics, and plenty of light in northern climates. If a good system of ventilation, other than by windows and doors, has been installed, so much the better, and it should be carefully studied until understood, and then kept in maximum working order. In all barracks, ventilation and heating are closely related, and should receive the

company commander's personal consideration. If it be practicable, it is a great help in ventilating most barracks to have a small open-grate fire going all winter, but there is usually no provision for it. The air in the squad-rooms should at all times be sweet and fresh, and free from the "closeness" and staleness that is particularly apt to obtain in the early morning hours of winter nights. The means of insuring this will vary in different places, but there is always one expedient that may be resorted to — raising the lower window-sashes, and fixing boards beneath them, with nails if necessary, so as to allow the air to enter in an upward direction between the two sashes. Inspections should be made occasionally, at the times indicated, to see that the air is good; while all arrangements to promote ventilation should be inspected frequently to see that they are in working order and have not been interfered with. In case interference is found, it is well to detail a man in each room to be responsible for their correct maintenance. All squad-rooms should be opened and thoroughly aired each day, in addition to the constantly working arrangements.

The need for good ventilation increases with crowding, and some of the most tragic experiences of our armies in the late great war arose from the almost or quite unavoidable overcrowding of men in barracks, cantonments, camps, and billets, in violation of well-known principles of hygiene and at times of exceptionally cold weather and of shortage of fuel, so that ventilation was greatly interfered with for the sake of warmth. The frightful prevalence of respiratory diseases and the toll of death exacted by them were related to this overcrowding in a quite definite manner. From the early

months of the war when the training camps opened with quite inadequate accommodations, through the days of divisional training in camps and cantonments, on transports and on troop trains and in billets in France, our men were crowded in ways and to degrees which would have been wicked if avoidable. The disastrous result was foreseen and warned against, but the necessity for getting large armies formed and sent abroad at the earliest practicable date was so great that it was [thought to justify the sacrifice which the only possible method of performance entailed. But nothing less than America's great contribution to the winning of the war could have justified the losses from respiratory diseases.

Always in the tropics, and during warm weather in other climates, all windows should be provided with screens to exclude flies and mosquitoes. If such is not the case, bed-nets must be used at night.

In cold climates double or storm doors and windows may be provided. They make the rooms more comfortable and easier to heat, but should not be allowed to impair the ventilation.

Water-closets, bath-rooms, and wash-basins should be entirely away from the squad-rooms, in which no plumbing should show. Articles of food, dirty and wet clothing, and useless trappings should be excluded as far as practicable. Floors should be sprinkled frequently with wet sawdust, and swept so as to create as little dust as possible; and at least once a week the entire room and its contents should be so thoroughly cleaned as to pass the most rigid inspection, no dirt, dust, disorder, or vermin being anywhere present. This inspection will be made usually on Saturday, and should be preceded

by an outdoor airing of bedding and change of bed-linen on Friday. At the inspection all wardrobes, drawers, lockers, and boxes should be opened, and their contents exposed to view. The small spaces and corners about such articles, the space behind or under radiators, the tops of wardrobes and shelves, should all be examined, and, if any man seem unclean, his linen and person.

The *day-rooms*, or recreation-rooms, should be suitable for their purpose, should have good light, good air, comfortable heating, and such provision in the way of chairs, tables, reading matter, billiard and pool tables, and other facilities for amusements, as will conduce to the interest, instruction, and amusement of the men, or such, at any rate, as can be obtained.

These rooms should be kept clean and neat at all times, free from dust, foul air, dirt, and vermin. The care should be such as to enable them to pass the same general inspection as squad-rooms. Smoking will be indulged in, in recreation-rooms, at most times of day, but the rooms should be opened and aired frequently. Spitting will also be indulged in, and cuspidors containing water should be provided in sufficient numbers to prevent spitting on the floor, and any man then doing so should be punished. The cuspidors should be emptied and scrubbed daily.

Pictures and ornaments may be permitted to some extent, to detract from the bareness and add to the cheerfulness of the room; but, in general, unnecessary dust-collecting articles should be excluded.

The *dining-* or *mess-room* should be sufficiently large to seat comfortably at table at least ninety per cent of the command. A certain number of men will necessarily

be absent from each meal — on guard, in the kitchen, on pass or furlough, and for other reasons — but provision should be made for the maximum number that may be present. Lighting, heating, ventilation, and screening, are all important here as in other rooms. Screening, particularly, should be carefully provided, and every means employed to keep the place free from flies. The cleanliness of this room should be as nearly perfect as possible, and while it is permissible to have the room attractive, dust-gathering trappings should be excluded. The mess-tables are used uncovered, or covered with white oilcloth. The former is the preferable method, as it insures thorough cleaning and scrubbing, if the tables look clean. An oilcloth can be made to look almost or quite its best by a small amount of indifferent rubbing, though it really may not be free from grease and dirt.

As said before, the men should be required to observe the decencies at table, and they are more apt to do so if the decencies are observed toward them. The table should therefore be orderly and attractive, though plain, the dishes and utensils should be perfectly clean and arranged in a proper manner, the food should be served in an orderly, attractive, and appetizing way, and with a sense of fitness. While parlor manners may not be expected in the barracks, gross indecencies of manner, speech, or action should be prevented. The room and table should be well cleaned after each meal, and the dishes and utensils should be carefully inspected daily and their perfect cleanliness assured. Once a week, or oftener, the tables and floors should be thoroughly scrubbed with lye and water, and vinegar-cruets, salt-cellars, mustard-pots, etc., well washed and filled.

In warm weather, fly-paper and, if necessary, occasional fumigation with pyrethrum fumes, should be used to supplement the screens.

No man should be allowed to eat with unclean hands, and it should soon be a matter of habit for all men to come to the table clean as to hands and face, and neat in appearance. Leisurely eating and thorough mastication should be encouraged.

After the squad-rooms the *kitchen* is probably the most important room in the barracks. Its importance has been discussed elsewhere, but may be emphasized here. It should if practicable be a large room, well lighted and well ventilated, opening on a large porch, and connecting with store-rooms, in the cellar or elsewhere convenient, and with a roomy pantry, with abundance of shelving, and drawers, also well lighted and ventilated. Good tables, sinks, running water, ample drainage, sound and smooth meat-block, and amply large range, and abundance of good kitchen furniture and utensils should be provided. A large ice-chest and some screened shelving should be near at hand. It is desirable, if practicable, to have a large hood over the range, to catch and conduct away, through a ventilating shaft, the odors, vapors, and smoke arising from the cooking. All of these articles should be frequently inspected to make sure that they are always cleaned as soon as possible after use, and never put away in any other condition. The cook, above all men in the company, should live, think, and dream cleanliness, and he should be held most strictly to account for shortcomings in that line. The kitchen police should be rewarded for efficiency in such a way as to make the detail desirable, and in this way the kitchen should be

made an object-lesson and a school of cleanliness. The inspection of the kitchen should include the pantry and ice-chest, should take note of, and remedy, waste or poor management, and should always embrace inquiries concerning, and search for, flies, roaches, mice, and other vermin. Cats, dogs, and other pets, as well as men not there on duty, should be excluded at all times. Garbage-cans should be outside of the kitchen, should be emptied at least once a day, and then cleaned inside and out; otherwise they speedily become a foul nuisance.

Kitchen management and hygiene were much better and the prevalence of alimentary tract infections much less during the great war just closed than in any of our other wars. In this respect we were able to and did utilize the knowledge we possessed.

The general remarks as to the lighting, heating, ventilation, and cleanliness apply to the offices and the shop-rooms for the baker, tailor, and cobbler, and the inspection of these latter should not be omitted, otherwise they are especially apt to form accumulations of scraps, dirt, and dust; and they are especially favorable distributing points for vermin.

The company barber should be required to keep his brushes, combs, razors, and utensils thoroughly clean, and to sterilize them frequently. He should be obliged to keep an abundance of clean towels and aprons, and to be liberal in their use. He is not apt to be so of his own volition. He should be instructed not to shave or cut hair for men with skin diseases without first getting the surgeon's assent. Should his own skin or hands show disease, he should consult the surgeon.

Store-rooms do not need light, air, and heat in such liberal amounts as do living-rooms, but they should be

dry, free from vermin, and should answer the purposes for which they are required.

Bath-rooms should be well drained, well ventilated, and well lighted, and when such is not the case every effort should be made to correct the condition. Lighting is facilitated and cleanliness promoted by having walls, doors, and partitions painted white. Where tubs are installed, they should be thoroughly washed and cleaned after each use, and the floor should be kept clean at all times. Each man should have his own soap and towels, and should take them to and from the tub with him. When tubs are not sufficiently numerous to accommodate the men as they wish to go, they should be detailed by roster to bathe, at least once or twice a week, and as much should always be required of them. Shower-baths are much more economical of both time and water, and are installed at most posts. They, as well as tubs, should have both hot and cold water connections, be frequently inspected as to condition, and be kept scrupulously clean. The drain openings should not be allowed to clog with soap and hairs, and the entire bath-room should be scrubbed at least once a week, and as much oftener as is necessary to keep it clean and sweet-smelling, and free from mustiness. Gratings should be lifted daily and the space beneath flushed and scrubbed. The same general remarks apply to the bowls for face- and hand-washing. The stoppers for these, and the chains holding them, should always be clean, the outlet openings likewise, and watch should be kept to prevent the formation of a film or coat of soap and dirt inside the bowls. The throwing of tobacco, paper, cotton, and dressings into bowls, tubs, or bath compartments should be forbidden and prevented. The man detailed in charge

of the bath-room should be cleanly and trustworthy, and should have authority to enforce the rules.

The water-closets are frequently in close proximity to the bath-room, and if both are kept clean there is no objection to it. Flush-closets and urinals are installed in practically all posts now, and where such is not the case one of the various expedients for disposing of excreta in the field will have to be used, and reference is made to their description. Flush-closets should be kept clean at all times, the bowls scoured, and the seats wiped off occasionally with a damp cloth. The floors about them should always be clean, and the room should be free from odor. Standing on the seats, defacing or defiling them, throwing stiff paper, matches, and other things likely to cause obstruction, into the bowl, and writing obscenity on the compartment walls should be punishable offenses. When a closet gets out of order in any way, it should be put out of use until repaired.

It is to be borne in mind that the use of carbolic acid and chloride of lime is but rarely necessary about flush-closets, and then not for the purpose of destroying odors.

Constant bad odors indicate lack of care or poor plumbing, or both, and should be corrected. When concealed by other odors, such as those of chlorine or carbolic acid, they may not be noticed, but the evil condition of which they gave warning is unremedied. Tissue paper is issued for toilet purposes, and no other should be permitted to be used, as being apt to scratch or irritate the anus, and to clog the drain. By signs in the room, and by verbal instruction, the men should be taught to wash the hands after every visit to the closet. It should also become a habit for them to inspect their feces before flushing the closet, as disorders may

thus be brought to their attention, and remedies sought. The passage of blood, pus, large amounts of mucus, or worms should prompt early consultation of the surgeon. The closet-rooms should be screened, and should be floored with cement to permit flushing, and to do away with cracks and crevices. Roaches and flies should be excluded. Each is indicative of unsatisfactory conditions. Sodium fluoride mixed with equal parts of an inert powder is recommended by the Department of Agriculture as a roach powder. Neither it nor borax, which is also much used, will suffice without cleanliness and constant vigilance.

Urinals are ordinarily flush-bowls, for use by one person at a time, or troughs for use by many, and should be sufficiently numerous to meet the demands of early morning and of the evening. The floor and walls immediately about them should be of smooth, hard, waterproof material, such as slate, in all permanent barracks, and should be washed thoroughly each day and then lightly wiped with a moist rag sprinkled with kerosene. Otherwise a crust of urinary salts is apt to form, and odors of decomposing urine to arise. When proper care and cleanliness are exercised, neither of these appear, and the use of deodorants is not necessary. The flushing of the urinals is usually automatic, and should be of sufficient frequency to prevent deposition of salts, though its action should be supplemented by washing and scrubbing of the bowl. If the outlet of the bowl is not already screened, a piece of wire gauze should be placed over it and held in place by a small stone or other weight, otherwise it may get clogged with bits of cotton, cigarette-stumps, and other waste thrown into the bowl. The throwing of such articles into urine

bowls should be punished, if detected, but detection is not usual.

It is neither desirable nor practical to have the men do their own laundry-work in barracks, but a couple of tubs, running water, and scrub-brushes should be provided, if possible, to enable them to do a certain amount of emergency work and cleaning.

The company commander should familiarize himself with the system of plumbing in his barracks, with a view both to detecting leaks and other faults, and to taking action for the institution of improvements where indicated, and likewise to fit himself to distinguish between poor plumbing and inefficient care of good plumbing.

Water supply. The water-supply of the barracks should, if possible, be of water fit for drinking without boiling or other special preparation. If this is not the case, the men should be warned and the proper drinking supply carefully defined and located. The general supply should be abundant for all purposes, and should amount to one hundred gallons per man per day, though so much need not ordinarily be used, and the amount really used will depend on a number of varying factors, such as temperature and climate, the character of the work done by the men, the care used, economy exercised, and the condition of the plumbing.

Where tub-baths are used, the consumption will be greater than if showers are used. While care should be exercised to prevent waste, it is usually false economy to hinder any reasonable use of water, as in bathing, scrubbing, watering plants or grass, or laying dust.

The water should be piped to the kitchen, the bathrooms, water-closets, urinals, wash-basins, furnace-

room, and to such places in and about the building as may be necessary for police purposes or fire protection. All faucets, exposed pipes and fire-plugs, and other parts of the water-supply apparatus, should be frequently inspected for leakage and as to their working conditions.

Except in the ways indicated above, the water-supply in barracks is not usually controlled by the company commander.

Plumbing. Good plumbing presupposes good materials, and such are usually furnished. Iron pipe should conduct the water-supply, and all joints should be tight. Faucets are usually of brass, and with proper usage rarely need repairs except new washers. Lead pipe is objectionable as being liable to cause lead-poisoning. Some water after a time will cause the pipes to fill partially or entirely with a deposit of mineral salts, or a growth of low vegetable forms, with a consequent lessening of the size of the stream. Such conditions, as well as advanced erosion, may necessitate renewal of the pipe. Kitchen sinks and wash-bowls should have their outlet-pipes and traps exposed and open to inspection, not closed in to become musty hiding-places for roaches. Kitchen sinks are usually made of galvanized or enameled iron or zinc, wash-bowls of enameled iron or porcelain. In any event, the surface should be smooth and capable of complete cleaning.

All should be effectively trapped to prevent the regurgitation of air or gas from the drains. Sinks should preferably have grease-traps, which should be easy to open and clean.

All bath-tubs should be of enameled or porcelain-lined iron or of zinc, and closet and urinal bowls of enameled iron or porcelain. All should be thoroughly

trapped, and ventilated on the ground side of the trap, by communicating with the ventilating pipe. No odor should come from them, and they should flush freely and effectively on all occasions. Whenever one of them is found at all out of order, flushing poorly or imperfectly, or emptying slowly, it should be put out of use until the fault is corrected. Such trouble, more often than not, comes from the use of newspaper as toilet-paper, or the throwing of matches and other improper objects into the bowls. Any leaking from a closet, urinal, or drain should be immediately corrected, as especially apt to cause disease. The maintenance of thorough cleanliness in the closet is incidentally the most ready way of learning of such defects, while the faults arising from its neglect are at times unjustly attributed to the plumbing.

Lighting. Of the various systems of lighting in use in our barracks, electricity is by far the best. Both oil and gas consume and contaminate the air, produce dirt and much heat, may be blown out, and give relatively poor light. Electric lighting produces no dirt, neither consumes the oxygen nor adds to the combustion products in the rooms, produces very little heat, cannot be blown out, and gives a brilliant, steady light that is very much better than either of the others. The danger of explosion is absent, and that from fires is reduced to a minimum by proper wiring. The lights should be sufficiently numerous to illuminate well all parts of the building, while in the reading- and recreation-rooms they should be numerous enough and placed low enough to make reading and writing practically as easy as in the daytime. A particularly satisfactory arrangement of electric lights is one whereby the source of light is hidden, the

light being reflected up to and back from a white ceiling, giving an even, steady glow without glare.[1] Dull and flickering light, such as is often produced by gas or oil, is very trying to the eyes, and causes strain and fatigue; while the vitiation of the air by the combustion of these substances necessitates much more liberal ventilation, or causes suffering. Economy in lighting should be practiced by extinguishing lights when the necessity for their use has passed, as in the dining-room and kitchen after they are cleaned, in the squad-room late in the evening, thus having more for use in recreation rooms.

Heating. As stated earlier, the subjects of ventilation and heating are so intimately connected that no consideration of the one is complete unless it includes the other. This is so for the reason that gravity is the most important factor in ventilation, and the weight of a given volume of air is less or greater as it is warm or cold. In other words, we influence or control gravity by

[1] "The four types of lighting systems in common use to-day are: daylight, direct lighting systems, indirect lighting systems, and semidirect systems. The evenness of illumination and the proper diffuseness of the light, with exclusion of all extremes of surface brightness, are ideal conditions best realized at present in the proper illumination of a room by daylight. As Ferree points out, before it reaches our windows or skylights, daylight has been rendered widely diffuse by innumerable reflections; and the windows and skylights themselves, acting as sources, have a broad area and low intrinsic brilliancy, all of which features contribute toward giving the ideal conditions of distribution stated above. The best distribution effects given by artificial lighting are obtained with the indirect systems in which the source is concealed from the eye and the light is thrown against the ceiling or some other diffusely reflecting surface. In the direct systems the tendency is to concentrate the light on the object viewed, and too often the eye is not properly shielded from the source of light. The semidirect systems represent a compromise in which a part of the light is transmitted directly to the eye through a translucent reflector, and a part reflected to the ceiling. Like most other compromises, this one is not ideal." — *Journal of the American Medical Association.*

means of artificial heat. The same force is the principal factor concerned in the diffusion of heat and heated air throughout barracks.

In summer, doors and windows can be kept open, and ventilation is seldom a very serious problem; but in winter or very cold weather, when doors and windows are closed and all the outside air is so cold that its impact causes discomfort, the case is different.

Open fires are suitable for heating single, small rooms, but not large ones, though the presence of an open-air fire aids in the ventilation of the latter as well as adds its cheer.

Stoves give more heat and less ventilation, for the same amount of fuel used, than do open fires. They may be made to promote ventilation greatly by being surrounded by a sheet-iron cylinder or jacket, into which a fresh air-shaft empties at the bottom. The air is warmed as it enters, and rises into the room through the top of the cylinder, and later escapes by way of stove-door, window-cracks, and sundry other outlets, including outlet-shafts, if such are provided.

The inlet should be screened to keep out dust and dirt, and the top of the stove or of the cylinder should always be provided with an open vessel of water, to moisten the air by its evaporation.

Cast-iron stoves give off carbon monoxide, a poisonous gas, when red-hot, and may so do harm. The air used in the combustion of fuel is taken from the room and passes up the chimney, fresh air replacing it from the outside, and quite satisfactory ventilation may at times be so maintained, even with unjacketed stoves, but it is not wise to rely on such means alone, especially in crowded barracks. Slow-burning stoves, such as an-

thracite base-burners, exercise much less influence in this way than rapid-burning wood or soft coal-stoves.

Hot-air furnaces operate by heating fresh air, which is brought to them through a ventilating shaft from the outside, and which, when heated, rises through the tubes and passages to the registers, whence it passes into the rooms. One advantage of this method of heating is that, with increased heat, in very cold weather it sends up an increased amount of fresh air. This air, though, is usually very dry if the water-pan of the furnace is not carefully watched and kept filled. This is due to the fact that air doubles its capacity for absorbing moisture with each increase of 15° C. in its temperature; so that outside air which at zero C. does not seem dry is excessively so when raised to 25° C. For this reason all systems of artificial heating should make some provision for moistening the heated air; which otherwise causes discomfort and harm.

The method of heating just described is not very much used in our barracks, being regarded less favorably than the steam and hot-water systems.

Steam-heating is very satisfactory and is much used. In this system the heat from the fire is transmitted to water, which is made to boil, under pressure if necessary, and the heat is carried throughout the building by the steam, which travels through tight iron pipes that expand into radiators in the various rooms. It is a rapid method of heating, and one easily controlled by an intelligent man, and such a man should be detailed in charge of it. He should maintain an even, steady fire, enough steam to make the rooms comfortable, and keep the water in the boilers at a constant and proper level. Such plants usually show their maximum efficiency

when a steam pressure of one or two pounds is maintained.

Water should be kept evaporating from the radiators, or, with a good man in charge of the system, steam may be allowed to escape from them to moisten the air.

Hot-water heating is somewhat similar, but the pipes are filled with water instead of steam. It is a very steady method of heating, but slower in either heating or cooling than steam. High and low pressure systems are used, only the latter in our service.

The air heated by the radiators is dried thereby, and provision should be made for moistening it.

When steam and hot-water heating are used, they are made to promote ventilation by having the fresh air enter the rooms through or under the radiators. It is thereby warmed and made lighter, and at once rises, to be later distributed through the room by gravity, convection, and diffusion. In order that it may not again be drawn through the radiators and redistributed, a line of less resistance should be created for it by ventilating shafts opening near the floor and leading to the roof, or by an open fireplace to answer the same purpose.

As there is also danger of fire in and about barracks, and as that danger is increased in cold weather, all chimneys, flues, shafts, stoves, furnaces, etc., should be thoroughly inspected and put into first-class condition in the late summer or early fall, before fires are started. Competent men only should be detailed in charge of fires, fire-drill should be held sufficiently often to familiarize the men with their duties in case of conflagration, and fire-buckets filled with water should be distributed about the buildings. As a matter of cleanliness, and still

more as a matter of hygiene, and especially in the tropics, this water should be renewed once or twice weekly, to prevent its serving as a breeding-place for mosquitoes. Frequent inspections should verify the thoroughness and effectiveness of this measure.

Vermin. The avoidance of mosquitoes, flies, roaches, lice, and other vermin has already been shown to be principally a matter of screening, cleanliness, and police; but if an old barracks is infested with bedbugs or fleas, it is often a most difficult matter to get rid of them.

The most effective way to do so is to give the building and furniture a thorough overhauling, scalding out cracks and crannies of beds, floors, and walls, with boiling water, washing them with *five per cent* carbolic solution, then closing all cracks with putty or strips of board, and painting over all. Infested clothing or bedding should be washed or steamed.

The Navy uses a liquid pest exterminator composed of five parts of crude carbolic acid in ninety-five parts of kerosene. This may be used as a spray where there is no danger of fire.

Frequent inspections should be made for the early detection of any recurrence or reintroduction of the pests, when their eradication from one room, or even from one bed, may suffice to end the trouble.

The large majority of Americans who have had military service had it in the war against Germany, and have had no experience with modern permanent barracks, knowing only the conditions which obtained in training camps or in foreign billets. It may be stated that the conditions in training camps were bad mainly because of lack of time to complete the camps before they were put into use and because of overcrowding. A

wooden hut heated by stoves, if kept clean and not overfilled, is not necessarily less hygienic and healthful than a much more elaborate and modern installation. The observation of the simple principles set out in this chapter should insure its equality in that respect.

CHAPTER V

CAMPS

The soldier's time is partly spent in camps, and occasionally the periods so spent may extend to many months. The conditions of camp-life are in many respects radically different from those in barracks; the old sanitary problems may have to be met in very different ways, while new ones arise, and sickness once started has opportunities to spread that differ somewhat from those in barracks. Our own unfortunate experience in camps of concentration in 1898, and again in 1917 to 1919, show that the assemblage of large bodies of raw troops into great camps is in itself a dangerous matter and that, if wise care founded on knowledge be not used to prevent it, diseases in epidemic form may create greater havoc than the enemy in arms. It is comforting to know that our experience of 1898 was not wasted in the late war, and that the group of diseases, typhoid and dysentery, which then did so much harm, was of almost trifling importance in 1917, 1918, and 1919. The Medical Department's end of the work was well done, and the faults of construction and supply were apparently unavoidable. In the A.E.F. also the principles of hygiene held good, and preventive medicine was successful where the conditions of shelter and supply gave it a fair chance to be.

The Medical Department must and does take the initiative in sanitary matters, and it naturally finds much satisfaction in excellent results, but it is only by having

the interested and intelligent coöperation of the line that the best results are attainable.

Site. At times the choice of the camp-site will devolve upon the company commander; at other times a site is assigned to him by higher authority, and he has no choice in the matter. It is, however, usually within his power to improve a poor site, or to impair or destroy the value of a good one; and whether he is more likely to do the one thing or the other depends largely upon his knowledge of military hygiene. The general principles regarding the selection, arrangement, and care of camps, as laid down in the Field Service Regulations, are to be observed, though they can at times be improved upon, and when such is the case it should be done. Let it be remembered that from a sanitary standpoint the important desiderata are: first, that the site should be clean and healthful; second, that it should be kept clean and free from infection during its occupancy; third, that it should be left so after the departure of the troops.

The consideration of the site of a camp must include an investigation of the healthfulness of the surrounding country, and in certain instances a very desirable site is wisely abandoned for one apparently less so, because the health conditions may be known to be better in the latter. For example, in the Bitter Root Valley in western Montana there occurs during the spring months a fatal fever, which is conveyed by the bites of infected ticks. These are found principally on the west bank of the stream, the eastern side being almost free from the disease. It would be wise, in that territory and at such a season, to forego considerable advantages that might be found on the western side, and to take the trouble of

crossing the stream, rather than to run the greater risk of infection with the "tick fever." A somewhat similar disease occurs in certain river-bottoms in Japan, and in that case the camp could be safely placed on the infected *side* of the stream, *above all levels subject to flooding*, as the infected insects are met with only at such levels. Oroya fever occurs only in certain narrow Andean valleys high above sea-level. Kala-azar is found especially in old and infected coolie lines and houses, and in Africa sleeping sickness is transmitted by a fly that is found only in or about thick underbrush close to water, and relapsing fever by infected ticks that appear principally in regular rest-places or camps.

The qualities desirable in a camp-site vary somewhat with the season, breeze and shade, for instance, being desirable in summer and undesirable in winter. The site should have a natural slope, to insure the speedy disappearance of rain-water from tents and streets. The surface should be as regular and smooth as can be obtained, free from numerous rocks and hollows. Stumps and trees are at times objectionable, particularly if numerous and close set, but at other times they can be put to a surprising number of uses, and those that are most in the way will disappear in a short time after the camp is made. The inequalities of surface due to numerous large roots or lightly covered rocks are, however, harder to overcome.

The soil of the camp site should be dry and firm, so as not to give rise to a great amount of dust in dry, or mud in wet, weather. Sandy or very soft loam is undesirable, and, in very windy seasons or neighborhoods, the dust it gives rise to may be a plague. A surface well set with grass is good, if not damp; but the grass will

soon die in tents and be tramped to pieces in the streets, and should be well cleaned up. The neighborhood of marshes or standing water should, if possible, be avoided, principally because they are apt to be infested with mosquitoes, but also because the ground may be wet. Ordinarily, high-ground water (shown by its nearness to the surface in wells or pits) makes for insalubrious conditions, much as do marshes.

Winds may be desirable or the reverse, according to circumstances. In regions where mosquitoes are abundant, a prevailing wind blowing them away from the camp is a great comfort, one in the opposite direction a great nuisance. However, certain observations in the Canal Zone have led excellent observers to believe that mosquitoes, especially certain species of *Anopheles*, may and do fly considerable distances, even up to a mile or more, against the wind to get to towns and camps, apparently attracted by the odor.

In wintry weather a strong wind always produces discomfort, and in summer it may do so because of the dust and dirt it blows, and in such circumstances shelter from it should be sought.

As sites are unhealthful or infected, in most instances, either because of the presence of disease-carrying and infected insects, such as mosquitoes or ticks, or because of their previous infection from human occupancy, old camps, marshy grounds, and places apt to present the conditions mentioned, should be avoided. While the avoidance of malarious swamps and of such disease-centres as have been mentioned above is of the greatest importance in regard to certain diseases, especially those that are insect-borne, it is usually camp diarrhœa, dysentery, typhoid, and other infections

disseminated largely by man himself that create the greatest havoc in camps. The danger from these usually increases with the length of time the camps are occupied, and with the increased opportunity for their defilement. This being so, bivouacs, temporary and permanent camps are apt to be defiled in an increasingly dangerous degree in the order named. Even a dirty bivouac-ground may constitute a menace to the inhabitants of the region, to other troops later following the same route, or to the command leaving it, or on its return that way.

The danger of infectious diseases is lessened by attention to the following points:

Shelter. The ordinary shelter of the camp is furnished by tents, which may be of any of the varieties issued for the service, though the shelter-tent is only exceptionally used, in one camp, for more than a few days at a time. All tents are apt to be hot in summer and cold in winter, objections partly met by the proper use of tent-flies. All are liable to be crowded, and the air to contain many micro-organisms when they are kept closed. This can be met by thorough sunning and ventilation, with walls raised, for a part of each day when the weather permits, and by the frequent removal, cleaning, and airing of all blankets, clothing, and accoutrements to which the moulds and other organisms adhere, and the exclusion of articles in or on which they may grow, such as food, dirty straw, trampled grass, empty but unclean bottles, cans, and boxes. All tents are apt to be damp in rainy or wet weather, and to lessen this they should be well ditched, so that all water from the tent-walls and the surrounding ground is carried away and the tent-floor kept dry. If the camp is to be occupied for any con-

siderable length of time, board floors should be furnished, or the interior be filled with fine gravel and rammed, while company streets should be raised and made hard and smooth by pounding or rolling; they can be much improved by sprinkling and treatment with crude oil, especially an oil that contains a large amount of asphalt base, as most California oil does. If floors are used, they should be raised occasionally and the space beneath thoroughly cleaned and aired. The general tent ventilation is also important in promoting dryness. Because of the dampness, men should always try to sleep off of the ground. In permanent camps they may have cots. Straw sacks are helpful, but they also should be raised if practicable. Cots or beds may be improvised from timber, or easily from bamboo, in a country where that abounds. Small branches of pine or other evergreen boughs serve to make a well-ventilated and comfortable bed where they are found. Boughs, cornstalks, loose-straw, moss or dry leaves may be available in bivouacs. In other camps than bivouacs these materials should be stirred up and aired daily and renewed before they become mouldy or much broken up.

Owing to the crowding in camps and the frequently poor bathing facilities, the opportunities for the spread of body-vermin are unusually good, and all precautions as to cleanliness, clothes-washing, and sterilization, if necessary, should be exercised to prevent their introduction and dissemination. Dogs, cats, and other pets should be excluded from tents and usually from camps. Mosquitoes are to be avoided by means to be considered later, but if they are present, nets must be used. Flies, roaches, rats, and mice are best kept down by the maintenance of such good police that they find no

breeding-places, and no access to food in or about the tents; hence the exclusion of food, boxes, cans, etc. In some places the camp is very apt to be full of fleas, and, as these insects do not stay long on their hosts and breed in the sand, floors, or bedding, cleanliness of tents, floors, and surroundings is most important, as the young live on decomposing animal and vegetable matters found there.

Because of ignorance, laziness, or viciousness, men at times urinate in or near tents instead of seeking urinals. The offense may not be readily detected, but it is none the less filthy and dangerous, and should be severely punished when detected.

Huts, *cabins*, and *dugouts* may be used instead of tents in long-established camps, particularly in cold climates or seasons. Because they are not so accessible to light, ventilation, or cleaning as are tents, even closer and more frequent inspections and greater care in cleaning are necessary, and particularly so in the prevention or elimination of vermin. At least once a week all clothing, bedding, accoutrements, and other accumulations of personal belongings should be moved outside and the places thoroughly inspected and cleaned. Such places as well as tents will require heating in cold weather, but as long as proper precautions are taken against fire and to provide for the escape of combustion products, this is desirable, as promoting dryness and ventilation, as well as comfort. Dryness of shelters and abundance of fresh air should be assured by all possible means, and to every man. All should work out of doors a part of each day. Wet clothes should be dried and dirty ones washed outside of the shelter, if it be at all practicable. Men with clothing or shoes wet from rain,

snow, or slush, should change them for dry at the first opportunity, and before lying down to rest or sleep. So far as military necessities permit, men, even those on guard, should be allowed to shelter themselves from inclemencies of the weather.

In France American armies had their first large experience of billeting and thousands of our citizens are familiar with the system. Its main advantage is that it shelters the army in buildings already constructed, with a minimum of expense and loss of time.

Some of its greater disadvantages for the army are the scattering and relative loss of control of the men, too intimate association with the populace and exposure to its diseases. For the population of the region the objections are still greater, including overcrowding, exposure to the army's diseases, interference with or disruption of family life, and, when the usage has obtained for a long time, as it did in northern France, serious danger of undermining the morals of the people. Consider what must be the strain upon the endurance and the morality, especially the sexual morality, of a populace deprived of its own virile males, yet in four years entertaining in its houses, which normally sheltered half a million people, five million strange males, all virile and all away from their own women-kind!

Water. The water-supply to permanent or semipermanent camps may be piped throughout them and delivered from stand-pipes conveniently placed. In other instances, it will have to be hauled or carried from wells, cisterns, streams, and other sources of supply, to the place of consumption. If it is known to be good and free from infection, it may be drunk as delivered; but when doubt exists as to its purity, and such will most

often be the case, it must be sterilized before use. Boiling destroys all disease-producing organisms that are found in water, and renders it safe. Prolonged boiling makes assurance doubly sure, but if fuel or time is precious, making certain that the water comes to the boiling point once may suffice, as that will destroy the organisms of typhoid, cholera, and dysentery. But it is at best a time-consuming process, and if the water is not well cooled it is not so refreshing, and men seek it from other sources.

The official method of sterilizing water is by means of calcium hypochlorite. The powder is issued in 1 gram tubes. One tube is usually enough to sterilize one Lyster bagful of water. Break a tube of calcium hypochlorite into a clean ordnance cup, moisten the powder with a few drops of water and mix into a smooth paste. Now fill the cup with water to within one inch of the top and mix thoroughly by stirring with a clean spoon. Add this solution to a Lyster bag filled with clear water, stir thoroughly, *and allow to stand thirty minutes before using.* After thirty minutes test a cupful by adding ten drops of a solution containing 10 per cent of potassium iodide and 1 per cent soluble starch and 0.5 per cent zinc sulphate. The appearance of a blue color is indication that sufficient chlorine has been added to the water. If no color appears the water is highly polluted and should be boiled if used. Water showing a high degree of pollution should be reported immediately to the medical officer having water-supplies under his supervision.

In emergency when a Lyster bag is not available, the hypochlorite method can be applied to smaller containers of known volumes by calculations based on the knowledge that a Lyster bag contains about thirty-six gallons of water. Thus if a ten-gallon container is available one quarter of the concentrated solution prepared in the ordnance cup as above can be added, etc. When smaller containers, such as two-gallon petrol tins, are used, the original concentrated solution in the ordnance cup can be diluted by one half, this dilution again diluted by

one half in another ordnance cup, and one quarter of this second dilution added to the petrol tin. By using a little ingenuity the hypochlorite method can thus be applied to any container of known capacity.

When the tubes of calcium hypochlorite are not available and the powder is available in bulk, the following procedure should be adopted:

(*a*) An empty shell used in Colt's automatic 45-calibre pistol will hold one gram of powdered calcium hypochlorite when filled level with the top. Always use this empty shell as a measure. Add one shellful of powdered calcium hypochlorite to an ordnance cup and make a solution as described above, filling the cup with water to one inch from the top. Part of this solution is used in titrating the water to be sterilized and the remainder is used for sterilizing the water.

(*b*) Rinse four ordnance cups with the water to be tested and fill all four cups to one inch from the top (500 c.c.) with the water to be tested. From a medicine-dropper add 4 drops of the calcium hypochlorite solution to the first cup; 8 drops to the second cup; 12 drops to the third cup, and 16 drops to the fourth cup. Mix the solutions in each cup thoroughly and allow the cups to stand thirty minutes.

Note. Twenty drops delivered from a medicine-dropper or a glass tube of 2 or 3 mm. bore is equal to 1 c.c.

(*c*) After 30 minutes add 10 drops of potassium iodide-starch solution from a clean medicine-dropper to each of the four cups and mix thoroughly. Some of the cups will show no color, some will show a blue color. The cup which contains the smallest amount of a hypochlorite solution capable of giving a blue color with the potassium iodide-starch solution contain the proportion of chlorine necessary to sterilize the water being tested. Thus, suppose the cup of water to which 8 drops (0.4 c.c.) of the hypochlorite solution was added gives a color with the potassium iodide-starch solution, and the sample to which 4 drops (0.2 c.c.) of the solution was added gives no color. The cup to which 8 drops was added contains the right amount of chlorine to sterilize the water being tested.

There are 36 gallons or 288 pints in the water-bag when filled to the white mark on the inside. Since 8 drops (0.4 c.c.)

of the hypochlorite solution were sufficient to sterilize 1 pint, 115 c.c. of the same solution will be sufficient to sterilize 288 pints in the Lyster bag. In practice it is believed to be safer to use twice the amount indicated by the titration, so that in the example quoted 230 c.c. of the hypochlorite solution would actually be added to the water to be treated, or one half of the concentrated solution in the cup to which the 1 gram of calcium hypochlorite had been added, could be added to the water in one bag.

The following table shows the amount of hypochlorite solution to add to a bag of water, corresponding to the number of drops used in the titration:

Number of drops..........	4	8	12	16	20	24	28	32
Amount of solution..... (cup measure)	¼	½	¾	1	1½	1¼	1¾	2

Note. In the titration if the first series of drops do not show a blue color the water requires more than one measure of hypochlorite. The second series of drops will indicate the amount of a second measure of hypochlorite dissolved in a cup of water to be added to the bag in addition to the first cup.

The Engineer Corps is now charged with the supply of pure water to camps and large commands, including, if it be necessary, chlorination at the source. After the water is taken over by the troops the Medical Department is responsible for any further treatment which it may require, such as boiling or chlorination. If reliably clean ice is obtainable, it may be added to the water. If its quality is doubtful, it may be packed around vessels of water, but should not be put into them. The general care of the water-supply as prescribed in Field Service Regulations should be observed.

There are no tests that can be quickly applied that will enable a medical officer to pronounce a given water-supply safe. He may form an opinion to that effect from

a consideration of the source and surroundings of the supply, but any idea that he can, by a simple and quick chemical test, or a microscopic examination of it, gain positive knowledge that it is pure and safe is fallacious, and should not be entertained. If the supply probably receives seepage from privies, stables, or homes, or washings from the same, or drainage from near-by cities or towns, it must be regarded as unsafe; and in other cases, where sources of contamination are not so evident, it is wisely precautionary to take the same view. In fixed camps there may be opportunities for the full and careful examination of water-supplies; but even when such is the case, and the water is found satisfactory, the condition may change in a day because of some accident or the carelessness of one or a few men. Boiled water should be used for many kitchen purposes, such as washing food-receptacles and such foods as are eaten raw. Boiled or actually boiling water should be furnished the men for washing their mess-kits. A good arrangement is to have for each company a box, a row of large kettles of hot water, at least one of them actually boiling, and a small mop or scrub-brush. As a man finishes a meal, he takes his mess-pan and implements to the place where these are, scrapes any food-remnants into the box, rinses the articles clean in the first kettle, passes to the second and there scrubs them with the brush, and then scalds them in the boiling water of the third kettle. Proper provision should be made, by means of a trough-container or otherwise, to prevent soiling of the ground with bits of food or greasy water.

Bathing. The water-supply should be sufficient to provide baths for the men. If the camp be situated on a stream or other body of water, it may afford proper

facilities in warm weather. Where such is not the case, and in cold weather, special provision will need to be made. Such provision will include a proper supply of water, sheltered and warm bathing-places, and a proper disposal of the dirty water.

The supply of water may be piped to the bathing-place, or it may have to be carried there. The former condition need not, ordinarily, concern the company officer, except that, if the water as delivered is very cold, most of his men will not bathe in it in cold weather. In case it has to be carried, each man should carry for his own use, and economy will then be exercised. The most effective use is then made of the water if the bather first scrubs himself from a basin, using soap and a rough cloth, and later rinses off the soap with a shower, which may be improvised by means of a large tin can and a piece of rope. Warm water should always be available, and may be kept so if a large can of water be kept over a fire near the bathing-place, and any man desiring to bathe be allowed to take from it, replacing an equal amount of cold water. A sheltered and warm bathing-place may consist of a room in a convenient building, of a special house, shed, or tent, heated, if necessary, by a stove, an extemporized brick oven, or other means. The floor should be hard and dry, or should be covered with wooden gratings to lift one above the waste water. If for lack of time or other reason a suitable bathing-place has not been prepared, and if it be cold weather, hot water may be furnished and men allowed to take baths in their tents. In such cases they should be careful not to spill water.

If bathing is possible only at the cost of considerable labor or inconvenience, a proportion of the men will

neglect it, and it is therefore desirable that a proper place be provided and the men required to bathe at least once a week; while the feet, face, and hands should be bathed oftener, and facilities should be provided for that. These may be just outside or inside the tents. The disposal of waste water is at times as great a problem as the procuring of the fresh supply, and it will have to be solved in different ways under different circumstances. In large or permanent camps underground drains may lead it away; at other times trenches may conduct it to a near-by stream or to dry wells or pits, and occasionally it may be necessary to collect it in barrels and haul it away. Always, care should be exercised that it does not flow or soak to the source of supply and contaminate that, and that it does not form breeding-places for mosquitoes. Where other provision is not made, fairly satisfactory results may usually be obtained as follows: A suitable space inside of a tent, say five or six feet square, is dug to a depth of four inches, and filled with gravel or fine stone, which is rammed. Over this a wooden grating is placed, and on the grating the men bathe. From the lower side of the space, trenches four inches deep and a foot wide are dug and filled with gravel or stones, and they conduct the water downhill to an open trench that leads it away, or to a soakage-pit about a yard square and deep, or larger if necessary, that is filled with large rocks, whence it soaks into the ground. Such pits, if in porous soil or gravel, will dispose of a great amount of water in a day. If in clay or close-grained soil, their working is not so satisfactory, and it may do better to run the water out in numerous, shallow surface-trenches from which it can evaporate. Similar precautions may

be taken to provide for the waste water from drinking-troughs for animals.

Bath-water should be freed from soap-curds before being sent to soakage pits or trenches. Otherwise this curd soon forms a coating on the sides of the pits and prevents further absorption. A system of baffle boards and straining through straw will usually remove the soap-curds.

Facilities for washing clothing should be provided in each company, though they need not be more elaborate than a supply of good, and preferably warm, water, a board, and a scrubbing-brush and soap. The waste water may be disposed of as indicated for bath-water. If a boiler can be provided for clothes, it is desirable to have it. In rainy weather a heated tent should be furnished in which to dry them, but at most times they can dry in the open.

Kitchens. As in barracks, so in camp, the kitchen is one of the most important parts of the command, and on its proper administration depends much of the cheerfulness, health, and efficiency of the men. The food should be abundant and good, and its preparation such that the men will be nourished and satisfied by it, and not under the temptation to gorge themselves with pies, milk, and soft drinks of doubtful character from outside sources.

The mess in fixed camps may be made quite as good as in barracks, and, except in rare emergencies, the articles of the ration are both good and abundant. As the problem of cooking is presented somewhat differently in the field and in barracks, the company commander, the mess-sergeant, and the cooks should all study the best methods for field service. Some excellent

garrison cooks are not nearly so good in the field, while others excel there. Economy, good management, and cleanliness are as important in the field as elsewhere, while, owing to the outdoor life and active exercise, the appetite is usually increased and more food required. Owing to the liability of chilling, exposure to wet, and the greater opportunities for intestinal infection, irritating, indigestible, and slightly nourishing foods, such as green corn and boiled cabbage, should be used sparingly, while green or overripe fruits should be forbidden. In the presence of epidemics of intestinal diseases, it makes for safety if only cooked food is eaten. Underdone cereals or vegetables are apt to cause indigestion, and as they are more difficult to cook thoroughly in the field because of the trouble with fires, wind, etc., particular attention should be paid to them. Rice, beans, hominy, oatmeal, and potatoes are probably most apt to be underdone. The methods of cooking in camp are various, the facilities ranging from the most simple and crude to the quite elaborate. Soup-carts, baking-ovens, and so-called fireless cookers may solve some of the problems; but the knowledge, industry, and management of the company commander, mess-sergeant, and cooks must be relied on to solve most of them. They must utilize to the utmost the articles of the ration, and such other good food-supplies as they can obtain, and the equipment furnished for cooking and such additions to it as they have or can prepare; and must put to use or minimize the harm of natural factors, such as wind, rain, snow, or poor fuel. It is the ability to do this last that enables some men who are not very good cooks in garrison to excel in the field. While a man knowing more of cookery may let a meal be spoiled or uncooked be-

cause of poor fuel, rain, and adverse winds, another man may have an excellent fire and a well-cooked meal in spite of all three. Camp craft results from experience and ingenuity, and the one should be furnished by manœuvre-camps and practice-marches, and the other encouraged by observant company commanders when it manifests itself. The man possessing these qualities will get the most from his utensils and his fire, whether he has a fully equipped camp-stove, a spider and pots, or merely a trench of his own digging.

As far as possible, men coming in from a march or a guard should be supplied with hot food at once, and when camp is changed an effort should be made to supply a hot meal as soon as the regular meal-time comes. This means the use of rolling kitchens or fireless cookers, or the early establishment of the kitchen and the use of food that can be quickly cooked.

As in garrison so in camp, cleanliness of cooks, kitchen, and food are secondary only to the actual supply of food, and the lack of it will do more harm than partial starvation. Flies have greater opportunities to breed in camps than in garrison, dust is more abundant and blows about more freely, fecal contamination of hands, shoes, and clothing occurs more readily, and the facilities for storing food so as to protect it from all these are poorer. Consequently, the amount of care to be exercised is greater, and the necessity for minute and thorough cleanliness more urgent. The hands, persons, and clothing of the cooks and assistants should receive the greatest care. Tables, benches, blocks, cooking utensils, and everything about the kitchen should be cleaned as soon as used, and scalded, if it be possible, with boiling water. Boxes and bags containing food

should be frequently inspected inside and out, and their positions shifted, in order that insects may not gather in or about them. They should always be kept clean. Kitchen floors and surroundings should be raked, swept, or scrubbed after each meal, so that all particles of food and everything that might attract flies will be removed. Slop-buckets and garbage-cans should be washed after each emptying, and not allowed to become crusted with a greasy coat of filth. At least once a day a rigid inspection of the kitchen should be made and all points of kitchen police investigated. Reliable men should be put on this duty and rewarded for its proper performance. Mosquito netting or wire-gauze covers should be provided for the protection of food while it is awaiting preparation or serving. Sheeting or boxes should protect it from dust.

It is questionable whether screening the entire kitchen is always advisable. Cleanliness is necessary in keeping down flies, and if a kitchen is screened all around it is darker and has more angles and corners in which dirt and scraps may collect to attract them. As the door is of necessity frequently opened, they enter and are then kept in by the screening. Screening is an aid in preserving the food uncontaminated, but it does not justify even the partial neglect of the more important matter of scrupulous cleanliness.

The kitchen fire should constitute a small crematory for kitchen-waste, and the cook should endeavor to be as independent as he can of civilian scavengers and fatigue parties. Nearly all scraps and solid waste that are to be thrown away can be burned by him, and at times he can take care of most or all of his dirty water by devices to be described later. Every tin can that is

emptied should be thrown into the fire and all organic matter in or on it destroyed. Later it may be hauled away or buried.

The Arnold pit has been much used for some years and has often given great satisfaction. It is prepared as follows: A pit is dug about 60 inches long, 30 inches wide, 48 inches deep at one end, and 36 inches deep at the other. It is filled loosely with stones to a height a few inches above the general ground-level, and is banked on all sides to protect it from surface-water. The kitchen fire is built on these stones, and is inclosed on the sides, but the ends of the trough thus made are left open. All watery material, such as waste coffee and dish-water, is poured on the stones at the shallow end of the pit. The heat of the stones evaporates it. All solid waste, including tin cans, is burned in the fire. The ashes and débris are removed as often as it becomes necessary. This arrangement is improved by having the liquid waste first strained by passing it through a layer of straw or excelsior six inches deep, which would catch much of the fine solids and grease in it. The straw should then be burned and fresh supplied once or twice daily. It might be placed in the bottom of a large tin or other box, or in a shallow pit that drained into the larger one. At other times, when the particular conditions would warrant it, the water could be led away to a stream by such a filled trench as was described for the bath-water, provided it were first strained through straw. Otherwise the trench would soon become foul with a deposit of soap, grease, and food-particles. When garbage and waste water are hauled away for disposal elsewhere, the matter of emptying them from cans and loading them into wagons should be carefully done under the super-

vision of a responsible man, with a view to the prevention of spilling and the immediate cleaning up of any that may occur. Receptacles should be washed inside and out immediately after emptying, and should at all other times be kept tightly covered. Lime-washing the outsides of cans and the stands on which they rest renders the detection of dirt easier and is recommended. If abundance of good food is provided in the messes, the men have no proper excuse for indulging in improper food obtained from peddlers, and such persons should be excluded from the camp and its environs.

Disposal of waste. Papers, sweepings, and other ordinary camp litter, as well as horse-manure and stable-dirt, should be burned, and such disposal of it is easy and convenient. If not so disposed of, it is apt to become scattered, create a nuisance, and, particularly, to do harm as affording breeding-places for flies. A crematory may readily be improvised, and if a good draught is furnished, it may be kept burning continually with waste as fuel. Three forms of pit or crematory are as follows, and any one of them may be easily and quickly constructed:

1. A circular pit with a cone of stones, around which the fire is built, piled up in the middle.
2. A horseshoe-shaped mound of earth, or a niche dug in a bank, or a trench open at one end.
3. A cylindrical crematory, which may vary in size according to the size of the command and the amount of material to be burned. It may be made of mud, stones, brick, corrugated iron roofing, old garbage cans, or whatever is available and suitable. In general, its height should equal or exceed its diameter; it should have three or four openings, each eight to twelve inches

square, placed at equal intervals around the bottom as air inlets. If iron bars are available they may be built into the cylinder to form a grate above the level of the air inlets. In rainy seasons a roof or other covering should be provided. The writer has seen excellent results from all the following types of cylindrical crematory:

(*a*) One built of mud plastered thick around a barrel. Inlets are provided and the fire lighted. As the barrel burns out the mud bakes. This size will suffice for a company.

(*b*) One made from three widths of corrugated iron roofing, each three or four feet long and each having a square measuring eight or ten inches cut from one corner of it. The three pieces are hooked together with wire in such a manner as to distribute openings left by the missing squares at equal intervals around the bottom of the cylinder. When set up this cylinder should be braced and steadied by piling mud or sod about it. It should suffice for two companies and has the advantage of being transportable in very small space if the sheets are merely unhooked and laid flat one on another.

(*c*) Any size at all may be made from stone or bricks plastered with mud. One having the inside diameter of three or four feet at the top and a height of five feet or more should dispose of all the refuse of a regiment. One such in a camp of the 5th California Infantry in 1910 one day served to cremate a horse and another day a cow, in addition to the regimental refuse.

Like all other types of incinerator this requires moderately intelligent handling, as it is of course possible to smother almost any fire. The proper method, in case there is no grate to the incinerator, is to place large

stones or, preferably, empty cans loosely in the bottom, so that air may pass among them freely. On these, or on the grate, place a little wood and the dryest refuse and light it. Then place some wetter refuse, then dry, and so on until the mass is well lighted. Continue to put on small amounts of refuse at a time, not filling the cylinder, but placing the material against the side toward which the wind is blowing. At evening the incinerator may be filled and allowed to smoulder all night. Next morning it should be started again with wood.

A still better form of incinerator is the multiple shelf incinerator designed and constructed at the Medical Officers' Training Camp at Fort Riley, by Lieutenant-Colonel C. S. Williamson, Medical Corps. This incinerator is made in both stationary and portable types and is described, with plans and specifications for its construction, in *Notes on Sanitary Appliances*, War Department: Document 897, A.G.O.

The larger type of this incinerator, when started with 200 pounds of wood, consumed in twelve hours 18,000 pounds of garbage, without the use of additional fuel. This was with careful handling and under the direction of the originator. A similar incinerator at Brest was reported to have given little satisfaction, probably because it was not operated so carefully. The large size is supposed to be sufficient for all the garbage of a division. The smaller, portable type is for a regiment or battalion, while a still smaller one made from a metal oil barrel is said to suffice for the garbage of a company. All of these and numerous other ingenious and useful camp sanitary appliances are described in the document cited, which should be studied by all officers on duty with field troops.

Other forms of incinerator may be improvised to suit conditions, and bits of stove-pipe or other means of improving the draft or protecting the fire from rain can be utilized. These pits must be cleaned as necessary, and the ashes and unconsumed matters, such as tin cans, placed where they cannot constitute a nuisance.

Feces and urine. The proper disposal of the products of human waste, feces and urine, so that they may not create a nuisance or constitute a source of danger, is one of the most important problems of camp sanitation. The methods available are incineration, water carriage, various forms of carriage on land, and disposal in the soil. Considering these in turn it may be said of *incineration* that it possesses the advantage of safe and sanitary disposal with sterilization, it does not attract and breed flies and does not contaminate the soil or the water-supply. On the other hand, the first cost of the incinerator is large, the cost of upkeep and fuel excessive, carelessness in handling leads to the development of bad odors, and the equipment necessary constitutes such a mass of impedimenta as to make its removal ordinarily impracticable when the troops are moved.

The British Expeditionary Forces made eminently satisfactory use of the Horsfall destructor for the incineration of fecal matter at their base hospitals and other fixed stations, but incineration as practiced in our service has not usually been either satisfactory or economical. It was much used in our large hospital centres in France. The Horsfall destructor, so successful in the British service, was used, but it was modified by our engineers, to its great impairment of function.

As the writer's military experience lengthens, his conviction grows that the incineration of those materials

which are hardest to burn and most objectionable to leave about, materials such as horse manure, human feces, and kitchen waste, is simply an effort to make the best of a bad bargain. The waste of fuel for this purpose in some of our divisional camps and cantonments in 1917 and 1918, and especially the waste through the use of the Guthrie incinerators which were built as part of the camp installation, was enormous, and that at the very time when the country was suffering from fuel shortage. Moreover, the waste of valuable hog-feed and fertilizer is inexcusable if avoidable. So far as the fuel is concerned, demonstrations of successful working by various types of incinerators, especially those discussed above, show that great expenditures of it are not really necessary, but when such results are attained in our service it means that unusually qualified, careful, and interested men are operating the incinerator. Such men are rare in our service. The most common fault with our men is to want to get through with a bad job quickly, with resulting overloading and choking of the incinerator.

Water carriage is in some exceptional instances an excellent method of disposal. The conditions under which this is true, however, are relatively few. It may be applicable if the camp is known to be permanent or semi-permanent in character and is situated on or close to tidal water or a stream not used for drinking purposes, that will remove the excreta promptly or at short intervals. It may also be used in camps of very temporary character if they are so situated in regard to tidal or running water as to make its utilization for the purpose both simple and inexpensive, for instance, the building of seats out over the water. In the former case

the installation may be anything from a complete sewerage and water-closet system to one as simple as in the latter case. Of intermediate arrangements a good one is the use of troughs of the Reed trough type, connected at their lower ends with drains of glazed tile that are laid with a good fall. The outlet of the trough may be closed by a hollow cylinder open at the level at which it is desired that the water should stand, say twelve inches from the bottom. Through this the accumulating fluid finds exit, and once a day or oftener the whole trough is flushed by simple removal of the cylinder.

Another plan, that has been found to afford a certain amount of satisfaction in a permanent camp emptying its waste into a small stream, includes large closed boxes or tanks made of concrete, though wood might be used, into and through which the sewage flows and in which enough sedimentation and disintegration occur to make the outflow a pale, opalescent fluid almost free from odor and easily visible particles. It is not contended or thought that the sewage is thus purified, but the plan has two distinct advantages in that it almost does away with bad odor, and it offers no encouragement for the breeding of flies.

This system, somewhat elaborated, was used on quite an extensive scale in many camps and cantonments of the draft armies. The installation was spoken of as a septic tank, but it was really what is here described with the addition of baffles to prevent the outflow of solids as rapidly as would have occurred otherwise.

Disposal by what may be called "land carriage" includes those methods that necessitate carrying or hauling the excreta through or about the camp, among them the pail system, the dry earth closet, carts, and

Reed troughs. They all have the common fault that, while they provide for the reception of the excreta as passed from the man, the matter of its ultimate disposition remains to be solved, and a satisfactory solution is always difficult and at times impossible. Among the expedients resorted to have been burial, burning, dumping at a distance from camp, dumping into water, and disposal in large pits. All are imperfect, laborious, expensive, and unsatisfactory; they are apt to constitute nuisances, to attract and breed flies, to pollute water-supplies, and in many instances to pollute the surface of the ground. Within the writer's experience one of the most satisfactory of these methods has been the disposition of the contents of Reed troughs or buckets into large pits where the surface of the refuse was kept covered with a layer of crude petroleum. This resulted in absence of odor and of flies, but the labor involved in handling excreta was considerable, that in digging pits more, and accidents occasionally happened which resulted in pollution of the ground in camp. Such accidents are liable to occur with any system that requires the handling or carrying of dejecta through camp. In addition each method has inherent objectionable features. Pails and boxes require much labor to clean them and much supervision is necessary to see that the cleaning is thorough and that covers are kept on in intervals of use, otherwise bad odors and flies abound. Dry earth closets are often not to be used properly because of lack of dry earth, the impracticability of separating feces and urine, the consequent mass of feces and mud to be handled, and the impossibility of keeping flies away from such a mixture. Like pails and boxes, earth closets are not easily moved with the troops. Latrine carts are

highly expensive because of the transportation and labor they monopolize. Reed troughs also demand large expenditure of money, labor, and transportation, and in addition, if used with lime in accordance with the War Department order prescribing their use, they neither sufficiently repel flies nor do away with bad odor. It may be said, though, that both of these objections may be met by the use of crude petroleum instead of lime.

A generally satisfactory method of pan disposal is the one used in many camps of mobilization in 1917, that of using galvanized iron box receptacles under fly-tight box seats, and having scavengers empty the contents of these boxes into covered iron tip-wagons painted inside with crude petroleum, and then paint the insides of the boxes with the petroleum also.

The objections set forth above will in most camps, especially of mobile troops, be sufficient to prevent the use of any method of disposal calling for transportation of excreta by land, and it therefore happens that we still resort to those ancient methods that have at other times been so faulty that all of these we have been considering were evolved as substitutes for or improvements upon them, namely, disposal on or in the soil.

Of these methods there are three principal ones:

Disposal on the surface of the ground with little or no covering.

Shallow burial.

Deep burial.

The first-named method usually merits only condemnation, as leading to contamination of soil, persons, water and flies, though it occasionally happens that circumstances will justify it. In a certain camp near San Diego, for instance, "hardpan" as hard as most

sandstones was found at or within a foot or two of the surface. The digging of deep trenches was impossible, as picks and crows were soon blunted and rendered useless, and when a trench was cut out to a depth of two and a half feet, the soil was so non-absorbent that urine quickly filled it. In the neighborhood were some small areas where the overlying soil was deep enough to permit of ploughing, and this had been done. A constant wind was blowing, and it was found that urine and strained kitchen water when thrown on this ploughed ground to the leeward of camp was absorbed by the loose soil and held until wind and sun completed its speedy evaporation. Such a method of urine disposal is certainly not ordinarily desirable, but in the case in question it was the best and safest available method, and military hygiene must in practice consist largely of doing the best thing possible at the time and place.

The second method of soil disposal, *burial in shallow trenches*, seems to have had considerable use in the British and Indian services, but it should not be used in camps of more than a few days' duration, unless special circumstances make it appear the safest or only available plan. Its most obvious faults are that flies can breed in feces exposed to them and then buried to a depth of only six to ten inches, that a relatively large amount of ground is necessary, that soiling of the feet with fecal matter is rendered more probable, that soiled paper is apt to be blown about camp, that a relatively light rain, especially in the tropics, will flood such shallow pits and diffuse their contents. When used the system calls for the constant presence of a sufficient guard to see that each man covers his own dejecta, that toilet paper is properly enclosed, weighted, or (after

use) covered, and to attend to the final filling, packing, and turfing of each trench at the proper time. The use of crude petroleum in the trench and as a partial covering for the fecal matter would lessen odor and flies.

The *deep trench latrine* is the form used in our camps of concentration in 1898, and it was condemned then and many times since as a contaminator of persons, soil, and water, a breeder of flies and of smells, and a constant source of supply where flies might and did load up with typhoid bacilli before visiting the kitchen and mess-tents. All of this was true, but more recently, since the importance of preventing pollution of the surface of the ground and of preventing access of flies has been appreciated, and since actual and extensive practice has demonstrated the feasibility and value of such precautions, it need be true no more. The danger to be feared from a proper use of deep trench latrines is pollution of the ground water, but as the introduction of a good supply of drinking-water from outside the camp is nearly always resorted to anyhow, that is not a vital objection, and ease of construction and simplicity make it certain that this form of disposal will long be used. When used though, the trench should be properly constructed and cared for if the evils above enumerated are to be avoided. First of all it should be dug to a suitable depth, usually six feet or more, and protected from rain, washings, and caving. Then it should be covered with a box seat with hole covers that close automatically, and all cracks and crevices closed in such a manner that the pit is made quite dark and fly-proof. Separate urinals of tin or tarred paper funnels opening into the pit by small angular tunnels should be placed at each end. They may be made im-

passable to flies by stuffing them lightly, toward the bottom, with grass or straw, although painting them inside each day with crude petroleum suffices for this and keeps down odor.

Various improvisations of pit covers can be made that will require relatively little lumber, if tarred paper, burlap, or cheap muslin be substituted for it on the sides and ends of the box and for seat covers. By keeping in mind the requirements of making the pit dark and fly-proof the resourceful officer can nearly always devise a satisfactory cover.

As to the subsequent care of the pits, it is thought that crude petroleum has advantages that put it in a class by itself as a pit dressing. It keeps down bad odors to a remarkable degree, is repellent to flies, does away with the use of earth or lime in pits, and indefinitely prolongs their usefulness in absorbent soils; it is easily handled and transported, and is of great value for many other sanitary purposes about camp. It should be used to paint the insides of urinal funnels and to sprinkle over the surface of the pit contents each day.

Crude petroleum appears to owe its value as a preventive of fly breeding mainly to the fact that it is repellent to adult flies. If maggots once hatch in a petroleum-treated pit they are apt to develop about as usual, despite the daily sprinkling with oil. Nevertheless, the treatment is still worth while, as, if continued regularly, it keeps egg-laying adult flies away and limits the output of the pit to the one crop of flies. Without the treatment numerous crops would appear.

Other methods of caring for pits are also in use but are not so satisfactory. Earth and lime are sometimes used to cover each day's dejecta. They do not keep

down odors or prevent fly breeding as well as the oil does, and they rapidly fill the pit and lessen its period of usefulness and necessitate extra labor to dig others. The burning-out of pits has also been much used and has usually given satisfaction. The results are about the same as from the above described use of oil, and when that is the case it seems a waste of labor to overturn each pit cover and replace it each day, not to mention the waste of fuel and the sometimes disagreeable features attending the burning.

The Jepson latrine and kitchen pits were among the earlier successful types of dark and fly-proof pits, and excellent results have been reported from their use in proper soils. They differ from other pits in that they are dug with a post hole auger and are small in diameter, but deep. They are to be covered in and made fly-proof.

Urinals should always be provided in camp, so that the men will neither need to urinate promiscuously through the camp nor to wet and soil the latrine seats. The day urinal may be a trough or a funnel of wood, tin plate, or tarred paper, that conducts the urine to a dark and preferably fly-proof soakage pit. The funnel or trough should be painted with crude oil each day, if possible, and great care should be taken to insure as far as possible that the men do not urinate on the ground near the urinal and so make a muddy and foul place. In case oil is not available for troughs and funnels, fairly satisfactory urinals may be made by digging pits and filling them with stones, or they may be filled with sawdust, or barrels or boxes with both ends knocked out may be half buried and similarly filled. Pine needles and sawdust are reputed to be especially

valuable for filling because they minimize or prevent the odor of decomposed urine.

Night urinals consist of large cans or half-barrels, to be placed in the company streets at night, and to be carried away and emptied and washed in the morning. If one emptying does not suffice to prevent overflow or spilling, they should be emptied also at ten o'clock at night. They should be marked at night with lanterns, so that they may be located easily. During the day, when not in use, they should be kept clean and dry and exposed to the sun.

The general interest of officers in the prevention of disease and their knowledge of the subject has increased so much in recent years that they usually show themselves efficient in maintaining good conditions. Nevertheless, they as well as the medical officer would be greatly helped if each company had an enlisted man whose duty it was to study and look after sanitary conditions. Army experience had convinced the writer of this, and his experience on the Canal Zone, where non-medical men who were formerly carpenters, railroad men, engineers, foremen, soldiers, and so forth, have been trained by working experience to become sanitary inspectors and have rendered service of the highest value, has strengthened the conviction. Such a trained man in each company would be of the greatest value to the organization and to the surgeon. Having acquired his training and demonstrated his value he should have non-commissioned rank and pay.

Camp sanitary work may at times need to extend beyond the camp and may include the improvement or protection of a water-supply, the search for and elimination of mosquito breeding in large areas, the drain-

ing of swamps, petrolizing of pools, grading and ditching of ground, the clearing of brush, and the regulation or control of traffic in food-stuffs. Under certain conditions it may include a quarantine system, a war on rats, a house-to-house inspection of civilians, the control of epidemics, or the sanitation of entire towns or districts. In all of these cases trained men are of especial value to the sanitary officials as well as to the company, though their value to the latter is constant.

CHAPTER VI

THE HYGIENE OF MOVING TROOPS

The march, the battlefield, changes by ship and rail, all present their special problems of sanitation, neglect of which may result in disaster to the careless command or to its friends and allies. Many men and some officers are apt to ignore the latter phase of the question and to think that when they have avoided harm to themselves and their companies they have performed their full duty in sanitary matters. Nowhere is a man his brother's keeper to a greater degree than in an army, and it is hoped that the fact may become more fully appreciated.

Marches. Article V of the Field Service Regulations deals well with the subject of marches; but the rules there given should be applied with discretion. It must be remembered that the various possible states of weather, roads, and personnel may result in an almost infinite variety of circumstances, all of which could not possibly be considered in any set of printed rules. Much must depend on the judgment of the commanding officer, in sanitary as in tactical matters, and his knowledge or lack of knowledge of sanitation may determine the success or failure of a movement. If good judgment is used in adapting the regulations to the circumstances, the rules laid down therein will constitute a reliable general guide. The length and speed of the march, for instance, must be materially influenced by climate, weather, roads, water, transportation,

weight carried, amount and character of sickness in the command, the rations, character and state of the clothing, the spirits of the command, the objective, temperance in the use of intoxicants, and other factors.

The length and frequency of rests must be influenced by much the same factors, and the commander who sets a pace and determines the frequency and duration of rests without regard to these influences is not doing justice to his men. The time of day during which the march is to be made will also influence the length, speed, and rests, and the choice of it must in turn be influenced by diverse considerations. Thus the temperature may make daytime marching very trying, yet the state of the roads, the possibility of malarial or other infections, the presence of sick, and other considerations, may make it appear the lesser of evils. It is always well, therefore, to consider these various influences and to bear in mind that the command brought into camp in good spirits and good condition after what may be a relatively short march, is in better condition for large accomplishments on the morrow, than another command that has marched five miles farther, but has reached camp with the men footsore, weary, discouraged, and with their vital resistance so lowered as to be ready to yield to the inroads of any chance infection. The influence of *climate* and *weather* is so quickly manifested on the men, and in such obvious and well-known ways, as not to need much discussion, and a moderate amount of common sense and consideration for his men should cause an officer to make allowances for them. Heat, wind, snow, rain, fog, slush, glare, mugginess, all tire, discourage, and tend to sicken the men, shorten the march, and increase the rests.

Closely related to these is the *state of the roads*. Mud, excessive dust, loose sand or gravel, very rough and uneven roads, all increase delay, vexation, and fatigue, and, even when weather conditions are good, may cut the march to a fraction of what is desired. Not to be separated from the question of roads is that of transportation. If the former are good, abundant *transportation* may be used, if available, lessening the loads of the men, supplying them with abundant food, tentage, and other necessities and comforts. If they are bad, transportation facilities may be much limited in consequence, or, if furnished, may prove a source of vexation and weariness, the men having to spend hours of toil extricating mired animals, wagons, or trucks in unloading, loading, and carrying freight. Such trials of body and spirit react on the health, and when, in addition, because of failure of the transportation, men have to lie down supperless and without proper shelter, the question of transportation has assumed a sanitary importance of magnitude.

Intimately related to the question of transportation is that of the *weight carried* by the men, and the attempt is wisely made to reduce this to a minimum; yet under some conditions, and generally they are those in which men should have to carry the least, as in bad weather, over bad roads, on forced marches, after very trying campaigns that sicken man and beast, transportation may fail and the men have to carry extra ammunition, food, and clothing. If this is a necessity the best should be made of it and the load carried, but the march should, as far as possible, be regulated to suit the altered conditions. We are not able to breed or buy men as we do horses, with a view to their

strength, speed, endurance, or spirit, though we do attempt to select them with a view to these qualities. Nevertheless, each organization will have its strong and its weak men, its fast and its slow, its cheerful and its despondent, and it is the less desirable of these that must be most considered under trying conditions. The weak man must not be overloaded, the lame man overmarched, because the more able men can march farther or carry more. Otherwise they will become sick, and the problem is worse complicated than before. Disregard of this simple fact has been known to result in most serious consequences. Whatever the weight carried, it should be so disposed on the person as to carry as comfortably as possible, and *not constrict or compress the chest.* As stated before, it is on the free play and efficient working of the heart and lungs that strength and endurance depend. If the chest is compressed and its mobility lessened by tight clothing, crossed straps, or other cause, that free and efficient working are impossible, and the man becomes exhausted under a load that might not greatly inconvenience him if it were more wisely disposed. Experiments have demonstrated that inhalations of oxygen enable athletes to run farther and faster, and with less inconvenience, than is the case without such inhalations. When the action of either the lungs or heart is interfered with, the oxygenation of the blood is hindered and early tiring, weakness, and exhaustion follow. These conditions constitute not only disturbing and delaying factors of a temporary nature, but also weaken the resistance to disease and prepare the way for infections.

Sickness in the command that is moving always occasions delay, often very much extra work, and, quite

as often, danger of epidemics. All sick should therefore be left behind, if possible, when the march begins; all hygienic measures should be employed to prevent other men becoming sick; all who do become so should report to the medical officer as soon as practicable so as to get the benefit of early observation, treatment, and care, and all who do not favorably and quickly respond to such early care should, if possible, be provided for on the way, in houses, camps, or hospitals, or sent back, and not allowed to hamper and constitute a danger to the entire command. The Field Service Regulations prescribe that the sick shall be eliminated before the start is made, but in practice certain classes of sick are not always eliminated and later give much trouble. Among these are venereal cases. Many such do not appear on sick report unless frequent inspections are made and they are ordered to report. These men, though doing full garrison duty and feeling well, are likely to develop buboes on the march and be unfitted for either walking or horseback riding.

Men recently discharged from treatment in hospital for malaria, dysentery, and other debilitating diseases are apt to become exhausted or to have recurrences of their sickness when subjected to hard marches.

Weak hearts and weak feet are liable to break down under similar conditions, and men known to suffer from either should be excluded. Not only should sick men be excluded from the march, but well men should be taught and, if necessary, compelled, to conduct themselves in such a way as to maintain their efficiency and strength. Alcoholism, particularly, should be discouraged, and all straggling to get alcohol and all drinking in ranks should be punished; for not only does the in-

dulgence lead to inefficiency from drunkenness, but it predisposes to exhaustion, infections, injuries, to heat-stroke in hot weather and freezing in cold. While only harmful and not to be encouraged in camp, drinking, if not carried to excess and not prolonged into the hours belonging to sleep, is then less directly harmful than on the march.

Cheerfulness and *bright hopes* are powerful stimulants to accomplishment, and it should be the aim of the company commander to keep his men in such a state of mind. Difficulties may often be laughed away, while if given too much thought or gloomily dwelt upon they readily become insurmountable. One of the great items in Napoleon's success was his faculty of having his men accomplish the impossible.

Hardships may be magnified in retrospect; on the march they should be minimized and belittled, if unavoidable.

Water. Another occasional cause of exhaustion is said to be the reckless and excessive indulgence in *water*. The Field Service Regulations state that under "ordinary conditions a canteen of water should last a man a day." Ordinary conditions in the field are, however, hard to define, and the amount of water needed under varying conditions and by different men varies greatly. There is no doubt that many men do use water injudiciously, and that, by training or habit, they may teach themselves such moderation and restraint as to be enabled to make the contents of one canteen last them through any ordinary day's march. As the canteen holds two and one half pints and the march rarely covers more than eight or ten hours, it may be seen that this should not involve any hard-

ship for a well and fit man. It is, however, a well-recognized fact that men who begin a march with the consumption of large amounts of water, and who early exhaust their canteens, are very apt to become exhausted or to fall out before the march is completed. The consumption of the water is not always the sole cause of such exhaustion, but both may be the effect of a common cause, such as sickness, diarrhœa, alcoholic indulgence, excessive smoking, or injudicious eating the night before. By the avoidance of such indiscretions the moderate use of water is made easy; but if a man has spent a part of the night in alcoholic indulgence, smoking, and eating cheese and salt herring, his system is so loaded with poisonous waste-products that he needs a large amount of water to dilute and remove them, and depriving him of it will not improve his condition in any way. Aside from such indiscretions, more water is required by men whose food is very salty or very dry; by those marching in a hot sun or losing much water in the form of perspiration, or those marching in dust, as at the rear of a column. Thus we see that while "excessive" use of water is harmful, its liberal use is not. On the other hand, insufficiency of water is harmful, even when not causing suffering through thirst, in hot weather as predisposing to sunstroke, and as causing such concentration of the urine as to cause very severe bladder irritation, with burning and pain that occasion great suffering and alarm. It is nevertheless highly desirable that men should so conduct and so train themselves that they can be able to get through the marching hours without using more than one canteenful of water; and if for any reason they cannot do so, it is usually better that they should go thirsty than that

they should drink water from unknown sources or of doubtful character, as a few hours of discomfort from thirst, or an attack of pain in the bladder, are to be preferred to an attack of typhoid, cholera, dysentery, or parasitic infestation. Sunstroke, however, may be as fatal as any of these, and if symptoms of it appear, water must be used, under the direction of the surgeon, if one be present.

The water problem should be handled as follows:

Before the march is begun, an abundant quantity of good water, boiled, filtered, or purified chemically, if necessary, should be supplied. If the water is boiled, that should have been done the night before, in order to have it cool in the morning. If other vessels are not available, it may be put in the canteens the night before and allowed to cool in them. Each man should drink what he wants before starting, using his cup for the purpose, and have his canteen filled from the food supply. Except rarely, he cannot know that the water he sees later in the day will be suitable for drinking, and he should therefore drink then only from his canteen, and, in order that it may suffice, exercise great care and moderation in the use of that supply. As soon as camp is reached in the evening, the preparation of a fresh supply should be begun, and, if boiling is the form of purification used, the first drink furnished may be tea or coffee. Reckless or careless indulgence in water from supplies of unknown character may have the most disastrous results.

Field Service Regulations say that " sources of water supply are examined by experts and marked *good* or *bad.*" It is a difficult matter and a time-consuming process for an expert to determine whether or not a water

supply is good or bad, and on the march a medical officer can only base his opinion on the source and surroundings of the supply as he can see them or learn of them from others. The appearance, odor, taste, and such other tests as he is able to apply under the circumstances can in no wise assure him that the water is fit to drink. It is therefore usually desirable that all water from sources not well known to be good should be purified before use for drinking.

Smoking is apt to increase thirst and should therefore be discouraged on the march, particularly if the water-supply be small in amount or of poor character. The use of chewing-gum tends to lessen the urgency of the desire for smoking and also to lessen thirst, and may be regarded as helpful for those reasons. It is sometimes urged that cold weak *tea* or *coffee* be carried in the canteen and drunk on the march, in order to assure the use of boiled water. Aside from the possibility of their being diluted with unboiled water, and of tea being made with cold and unboiled water, these drinks are not so refreshing and thirst-satisfying between meals to most Americans, as plain water, and it is not thought that they are as good for use on the march as the latter, provided that it is properly purified or sterilized.

Food. The food-supply on the march, as elsewhere, is very important. Because of the greater amount of work performed, and the increased tissue-changes due to the outdoor life, the amount of food required on the march exceeds that required in garrison; while because of the few and imperfect kitchen facilities, the new and strange environment, the absence of water-closets, and for other reasons, food infection is more apt to occur, and every effort should be made to obtain

cleanliness and to serve all food sterile, rendered so by heat. Because of the exposure to which the men are subjected, diarrhœal troubles are readily induced, and irritating foods should be avoided. Except in rare instances it should be possible to furnish two hot and substantial meals a day to the marching column, and that should be done. A hot breakfast should be served before the march is begun, and it should be a substantial meal, such as one of meat, potatoes, bread, and coffee. Eggs and similar articles, if obtainable, may be used. The noon meal, also, should be prepared and issued to the men before starting, and should embrace much nutriment in relatively small bulk. Fried bacon, cheese, sliced meat, and bread meet the requirements well, while a pickle, a bit of fruit, or jam adds to the enjoyment of it. In the evening, after the hard work of the march is ended, the men should have another hot meal, and as they will have leisure to digest it, it should be more bulky than the other meals. Stews, if well made, answer admirably, and may be supplemented with such additions as are obtainable, Because of lack of fuel, delay in the arrival of company wagons, the necessity of starting fires and doing the cooking after the halt is made, the evening meal is often late; and if they can obtain other food many men eat it, often with little regard to its suitability. Soup-carts, rolling kitchens, and fireless cookers correct this by having a ready-cooked and hot meal prepared when the halt is made. Because of their portability, canned and preserved foods are much used on marches, and the usual precautions are necessary to see that no spoiled cans are used. If this be done, they constitute fairly pleasant and very wholesome food-supplies, but they should be supplemented

with fresh articles when these are obtainable. The general care in the preparation of foods that has been indicated as desirable in camps should be exercised in the short camps made by marching troops.

Clothing. The Government provides suitable clothing for all varieties of climate and weather, and the company commander should see that his men are provided with the proper kinds and amounts to meet the probable needs of the march. Flannel shirts should be worn even in tropical climates, as they prevent too rapid cooling of the body and afford protection from the night chill. Blouses or coats are rather an impediment than a help in the tropics, if flannel shirts are worn, though more useful and comfortable than a sweater in cold weather, especially cold, windy weather.

The poncho or rain-coat should usually be carried and the blanket nearly always, even in hot seasons, as the night chill is often penetrating and is accentuated if the clothing or the ground be wet. The *mosquito net*, while not an article of clothing, may be mentioned here as most important in tropical countries, or hot weather. It is the soldier's most important protection against yellow fever, malaria, and dengue; while it may be quite as efficient in protecting him from tick-bites, from the flies that infest with screw-worms, from poisonous insects and reptiles. Its use, though the importance of it has long been recognized, is apt to be neglected on marches.

It is not considered necessary to discuss in detail the various articles and kinds of clothing to be worn, but some few articles need discussion. The drill regulations allow the marching soldier three pairs of *socks*, one pair on his feet, one in his blanket-roll, and one in his surplus

kit on the company wagon. In order to keep his feet in good condition he should begin each day's march with clean feet in clean socks, and must always have a dry and clean pair of socks for emergencies, such as the accidental falling into mud-puddles or streams. It is therefore necessary that he should wash his feet and one pair of socks each night, and the company commander should make sure that he does so, and that, if possible, he then has facilities, such as a fire, for drying the socks. *Trench foot*, a painful, long-disabling, and often very serious disease among men serving in the trenches on the western front, especially in Flanders, was due to prolonged, cold wetting of the feet, and very stringent orders as to the care of the feet had to be issued to the various armies. Socks should be not only clean and dry, but they should fit properly. If too long, they fold or wrinkle and make pressure or rub. If too short, they cramp the toes and may be as important in causing or aggravating corns, bunions, foot-cramp, and ingrowing toe-nails as poorly fitting shoes. In general a light woolen sock is much the most satisfactory for field use. Any disorders arising from the use of improper socks or from other cause should at once be reported to the surgeon, who, by timely advice or treatment, may be able to avert lameness or disability.

Shoes likewise are frequent causes of lameness, and in many instances the company officer is to blame for not seeing that his men get proper sizes and fits. At other times the Supply Department is at fault in not having proper sizes for issue. In such event the man chooses a shoe of improper size, or buys them of improper shape and material from civilian dealers. The footgear of the army has improved in quality of late

years, however, and most of the shoes now issued are excellent, both in shape and material. A proper shoe should be sufficiently long and broad, so that the toes are not crowded even after a long march. It should not make painful pressure on any place, but should fit snugly and evenly over the instep and about the heel, to prevent rubbing or forward slipping of the foot. The heel should be broad and low. Two pairs of shoes are allowed, one pair on the feet and one pair in the surplus kit. If practicable, the day's march should always be begun in a clean and dry pair, and it is therefore important that a part of each evening's work should be the cleaning, drying, and oiling of one pair. For the last-named purpose, a piece of fat meat will answer if other oil is not obtainable. Shoes left wet and dirty soon become hard, wrinkled, and uncomfortable, and "run over" and break more readily than those kept clean and supple.

Two suits of *underclothing* are allowed, one on the person and one in the surplus kit. As underclothing is even more important as a protection from dirt than from cold, these will also require frequent washing. Neglect of this may result in attacks of boils, ringworms, and other skin infections. When a day in camp permits it, and coffee tins or other receptacles are available for the purpose, underclothing should be boiled.

The *towel*, but one being authorized, will require frequent washing.

For general purposes and use in all climates, the campaign hat is very satisfactory, though discomfort and complaint have been caused by the stiff brim that has been used for some time past. With a soft brim it is unexcelled for general use, though in the tropics a

cork or pith helmet and in arctic weather a fur cap excel it for seasonal wear. The " overseas " cap has nothing to recommend it except its small bulk. It protects from neither rain nor sun.

There is no evidence of any advantage in red or orange hat linings.

Police. The general rules for camp police should be applied to marches as far as practicable, and they can be applied to a far greater extent than is ordinarily the case. In order to do this, proper instructions should be given in advance, and each company should have, as in camp, at least one man on sanitary police duty, whose business it would be to see to the proper disposal of waste matters, to prevent the careless and indiscriminate soiling of halting-places, to assist in preventing the use of improper water, and to do such other work of a similar character as the circumstances necessitate or the medical officer recommends. Men should not, except in urgent cases, be allowed to fall out except at regular halts. If the halt is a short one, the company commander indicates to the sanitary soldier a suitable spot for urine and feces. The man goes to that spot and marks it. All men needing to fall out go there and use the place indicated, afterward covering their dejecta with earth. If the halt is longer, half an hour or more, the sanitary soldier repairs at once to the designated spot and digs a shallow trench for the feces and a shallow pit for urine. All men should be instructed to use these places only, and the trench and pit should be filled in again before the march is resumed. In case a man, from urgent necessity, does fall out on the march, he should be instructed to cover his feces with earth, using his bayonet, if necessary,

for the purpose. Similar rules should apply to men on outpost or picket duty, and in this way much may be done to prevent the surroundings of a camp from becoming an ill-smelling, fly-breeding nuisance. Scraps of food, greasy papers, and other articles thrown away by the men at the halting-place should be thrown into one pit and burned or buried.

On arrival at camp, the sanitary soldier should immediately begin shallow trenches in a proper place selected by the medical officer, and men should be punished for urinating or defecating elsewhere.

In bivouac, or while actually marching, the men should take all possible precautions to protect themselves from, or to rid themselves of, vermin and insects, and in warm weather the use of the mosquito net should not be neglected.

Battlefield hygiene. The hygiene of the battlefield has been largely set forth in the consideration of the camp and the march. All the general principles there set down hold good and should be observed as far as possible. Often, however, the military necessities allow no time to be devoted to sanitary matters; but even so, the soldier who has been well trained to a realization of the importance of such matters will be able to take better care of himself and to do less harm to his comrades than the man not so trained.

Our experience in France wholly confirms this. During the battles along the Marne in July, 1918, and again in the Meuse-Argonne fighting, the impossibility of preventing surface pollution of the soil, of supplying purified water to all men, of affording opportunities for cleanliness of person, of feeding men satisfactorily at all times, was clearly demonstrated. The necessity

for moving forward, that for taking cover, for avoiding streams of machine-gun bullets, will always take precedence over less urgent measures of sanitation, and men will defecate and drink where they can rather than not defecate or drink at all. That sanitary evils and conditions favorable to the spread of disease should result need not be surprising, and it is important that the individual be all the better informed as to the principles of hygiene and so prepared to deal intelligently with unfavorable conditions.

The man going into battle should, if possible, observe all of the following rules in addition to the general care outlined above:

1. Make sure that you have a first-aid packet, that it is in good condition, and that you know how to use it.
2. Have your canteen full of good water.
3. Be clean in person and clothing, be bathed, and have on fresh underclothing.
4. Have your bowels and bladder empty.

All of these rules have an important hygienic bearing in case he should be wounded. The introduction of the first-aid packet in its present form was one of the greatest improvements in military hygiene ever consummated, and it has prevented an immense amount of suffering, mutilation, and death. For a large proportion of wounds, a properly applied first-aid dressing constitutes the most important part of the treatment, and, in many cases, the whole of it. With such a dressing at hand and a knowledge as to how to apply it, the use of water on wounds is very rarely necessary. But if water is used, it is most important that it should have been boiled. Otherwise it may infect the wound most

seriously. Cleanliness of person and clothing are very important for the same reason, to prevent infections. Most infections of wounds are caused by bacteria derived from the skin or its coverings, and by simple cleanliness of these, surgeons are daily able to, and do, make extensive wounds that heal without a trace of infection. The importance of having the bowels and bladder empty, or relatively so, lies in the fact that wounds of these viscera are exceedingly dangerous, but that the danger is directly lessened with the chances of excremental soiling of the tissues. For this reason, eating, drinking, and moving, all of which increase or facilitate the escape of intestinal or bladder contents, are to be avoided in the case of belly wounds, and for the man so wounded we may formulate another rule:

5. If wounded in the belly, lie down in the most comfortable position, eat nothing, drink little or nothing, do not move, do not get excited or restless. If overlooked or forgotten, you may be better off than if found and transported.

Transport ships. The sanitary disadvantages under which men travel on our army transports are numerous, but they are mostly beyond the company officer's power to remedy. The transport regulations provide for such sanitary measures and daily inspections as would seem to assure good conditions, and the conditions are such that with the aid derived from sea air and changes of scene the health of the men is usually well preserved or improved. *Overcrowding* is an evil frequently encountered on transports, and one from which others flow. The company commander is quite powerless to prevent this, but he should lessen the evils of it by having his quarters as freely ventilated

as possible, having them policed each day, and vacated by both men and their belongings when opportunity offers. Overcrowding was undoubtedly a factor in promoting the spread of influenza and pneumonia on transports in the fall of 1918, at which time the mortality from those diseases was very serious. When, as seemed the case then, such crowding is unavoidable, it is important that other means be employed in lieu of space for the separation of one man from another. The use of shelter-tent or other partitions between men in such narrow quarters as are allowed on a crowded transport makes much more difficult the already difficult problem of ventilation, but it may be justified, in the presence of epidemic of respiratory disease, for the reason that droplet infection is more dangerous than rebreathed air.

The company commander should see that his men go aboard transports with clean underclothing and that they change as necessary.

Transports are not infrequently infested with *bedbugs* or *body lice.* The company officer can only partially correct this evil by the police and cleanliness of his quarters, and, at times, by bug hunts and the use of insecticides. In Canal Zone barracks, which are provided with bunks similar to those on transports, bugs are destroyed by boiling the canvas and its stretcher frame and flaming the upright supports with a gasoline torch.

The *food* on transports is usually of good quality and very nourishing, but the methods of *cooking* and *serving* it are almost always monotonous and unattractive, and result in unnecessary waste, improper methods of eating, and some disgust with the food. The

company officer should try to influence these conditions for the better, so far as he can do so. Owing to the long confinement in exceedingly narrow limits during the trans-Pacific voyage, unremitting attention to all sanitary details is urgently demanded. All cases of sickness or disease of any kind should be reported to the surgeon early, in order that he may isolate contagious diseases, as well as give treatment. The two ills from which a majority of men suffer are seasickness and constipation, the former at the beginning of the voyage, the latter throughout it. The tendency to *seasickness* is lessened if the man goes aboard the boat in good general condition, with his bowels cleaned out and his system free from the poisons produced by overeating, alcoholism, and other excesses. Constipation should be prevented, if possible, by the use of rather bulky foods, such as oatmeal, fruits, and vegetables, by daily exercise and a well-maintained habit of visiting the closet regularly and making the effort to defecate.

Troop trains. Under varying conditions, troop trains may be composed of any kinds of cars that are in use. The general principles of troop hygiene should be applied as far as practicable, whatever the accommodations. The most common faults in troop trains in time of peace are poor policing and dirty cars, and an insufficiency of water for drinking and cleaning purposes. Both of these faults are usually attributable to the railway officials, but the troops are partly to blame in that they are sometimes careless and wasteful of the water, and make very little effort to keep the cars clean. The company commander can therefore partially control the evils. He should also make it his particular care to see that the car closets are well supplied with

water for flushing purposes, and that the supply is replenished as opportunity offers.

Troop trains as used in the United States in 1917 and during the war were generally quite satisfactory and, as compared with those used in France, quite luxurious. The objections to the French troop train of freight cars are so numerous as not to justify discussion, but they were the only trains available and similar ones will again be used under similar circumstances; in which case it is to be expected that men will suffer from heat in summer, from cold in cold weather, from general discomfort at all times, from long delays and generally from poor sanitary service, including water-supply. Water stations, where purified water can be obtained, should be provided, or there should be chlorination of water in Lyster bags carried on each train.

CHAPTER VII

THE HYGIENE OF HOT AND COLD CLIMATES

THE general principles of hygiene are the same the world over and may be applied in any climate. They aim to keep the body strong, sound, free from infection, and at its maximum efficiency. Inasmuch, though, as the dangers of infection as well as of injury from extremes of temperature are somewhat different in the tropics and the arctics, it is well to give these conditions separate consideration.

HOT COUNTRIES

The danger to life and health is greater in nearly all tropical countries than in those that are temperate. This is due to a number of causes, among which we may note the almost total neglect or ignorance of sanitation among tropical peoples, the high, even, and often moist, temperature in which disease-producing organisms flourish and multiply, the great abundance and variety of insect-life, the common pollution of water-supplies, the habits of dress, and the heat itself. It is sometimes said that the safest procedure in matters of hygiene in strange countries or climates is to conform to the habits of the natives, but this is often a very serious error, and it has undoubtedly cost many lives. It is faulty habits in the natives that help to keep alive, in the tropics, many diseases that have long since almost or entirely disappeared from temperate climes, while the people sicken and die of preventable infec-

tious diseases in far greater numbers than should be the case.

Water. The native of the tropics is very apt to suffer from water-borne diseases, and cholera and dysentery, although not limited to tropical climates, are so much less prevalent elsewhere as to be relatively rare, even if not unknown. The native is influenced in his choice of a water-supply by convenience, superstition, habit, and the fact that his ancestors did certain things, but not often by sanitary considerations. For this reason he suffers from the diseases mentioned, and partly for this reason he practically always harbors one or more varieties of intestinal worms. The only safe rule for general application to drinking-water in the tropics is that it should be sterilized by boiling, distillation, filteration, or chemical treatment. But this alone is not sufficient. The water must be kept sterile until consumed, by being put in sterile containers and closed against all possible contaminations. Both Filipino and Chinese servants in the Philippines are so entirely ignorant of the very meaning of sanitary precautions, that they are continually guilty of such action as stoppering bottles of distilled water with corks they have held in their mouths, wiping out a drinking-glass with a dirty rag or paper picked from the floor, drinking direct from bottles, and bottling unboiled water rather than take the trouble of boiling it, and it is feared that not all soldiers are free from some of these faults.

Food. It is generally asserted, and is theoretically true, that less food is required in the tropics than in colder climates, and that the fats and proteids in particular should be considerably reduced. This may be admitted, but we must also admit that lifelong hab-

its, exercise, and temperament exert an influence that cannot be ignored, and any arbitrary attempt to put American soldiers, especially if they be doing field-work, on a ration approaching the rice-and-fish diet on which many natives of the tropics live, will result not only in discontent, but also in impaired nutrition and in clandestine indulgence in food or drink of improper character. The present army ration is thought to be excellent for the tropics, as for home, provided that the men *work and exercise as at home.* If such is not the case, the ration is too heavy and should be reduced as indicated. The sugars and starches are well borne in the tropics, are not such "heating" food as fat and proteid, and do not tend, in the same way and same degree, to cast an excessive amount of work on the liver and kidneys. Neither do they offer opportunities for such harmful forms of intestinal putrefaction. Organic acids, such as fruit-juices, are especially valuable and important, as well as agreeable, in the tropics.

Recent observations in Singapore indicate that there is a tendency to acidosis, that is, a relative lack of alkali in the blood, in residents of the tropics and, as the ingestion of fruits tends to increase blood alkali, it is possible that this fact accounts for our greater desire for and relish of fruits in the tropics and in hot weather.

Care must be exercised in the use of fresh fruits and green vegetables, not because they are in themselves harmful, but because they are apt to be contaminated, from unclean water or from fecal manuring, with the parasites causing intestinal diseases. The only safe plan in using them in countries where dysentery, cholera, and intestinal worms abound is to have them

sterilized: the green vegetables and some fruits by cooking; bananas, mangoes, oranges, and similar thick-skinned fruits, by thorough washing in boiled water. A large part of the food consumed by white people in the tropics is preserved by refrigeration or by canning. It is as good there as elsewhere, but is apt to decompose rapidly after exposure to the ordinary temperature and atmospheric conditions, and should therefore be used promptly after such exposure.

Owing to the facility with which potatoes and similar vegetables spoil, the tropical resident should early accustom himself to the use of rice, yams, and similar products. The use of condiments and spices is generally more liberal in the tropics than elsewhere. This is, partly at least, a matter of custom, but it may have a physiological basis in that these articles are stimulant to the alimentary tract. They are not known to do harm.

Alcohol. Alcohol is quite as much abused by northern peoples in the tropics as in their own homes, or more so. In real moderation, that is, in the amounts that can be completely oxidized in the body and used as food, it is not known that alcohol is more harmful in the tropics than elsewhere. In greater amount it is so, for the reason that alcohol in excess is in all climates an irritant to the liver, and in the tropics the liver is already hard-worked, irritated, "sluggish," and subject to congestions — conditions aggravated by the irritation from the alcohol. Like the proteins and fats it does less harm if plenty of exercise is taken to promote its oxidation and the elimination of the combustion-products. As in other climates, its use is only infrequently indicated, and abstinence from it is advis-

able. Its very general, and often excessive, use among soldiers proceeds not so much from any needs of the system as from idleness, vacancy of mind, evil examples or careless associations, laxity of public opinion on such matters, and absence of such restraining influences as home-life and respectable female society. It would therefore seem that the company officer can best combat the evil by attention to these points. Heat-stroke and heat-exhaustion are much more apt to occur in a man who is drinking, and to be more severe when they do occur. All drinking to excess is debilitating and probably lessens the resistance to infections. Recurrences of malaria and dysentery are not infrequently brought on by drinking-bouts or sprees. Alcohol also predisposes in more indirect ways to disease-infections, as by rendering a man neglectful of the quality of his food or the use of his mosquito net, and because he may use impure water with his drink, erroneously trusting to the alcohol to sterilize it.

Clothing. In general terms, the dress should be adapted to the climate and to insure comfort and protection. The clothing issued to the army fulfills these requirements, allowing variations in the underclothing to suit individual tastes and requirements. The cotton service cloth for outer dress is cheap, strong, durable, fairly cool, and easily washed. The flannel shirt for the field and those of cotton for barracks meet the requirements. British writers lay some emphasis on the desirability of always wearing woolen clothing in order to protect from chill, and much has been said as to the value of the woolen belly-band or abdominal binder. The writer's personal experience, and observations as to the general American experi-

ence, in the tropics do not indicate that this is a rule of general application. As stated before, most tropical diseases are infectious in nature, and if proper precautions be taken to avoid the infections, it is not thought that the discomfort produced by too great warmth of body, excessive perspiration, and prickly heat is apt to offer additional protection. In the field, where the chill of night air is more keenly felt and where wetting may occur from rain or from fording streams, the flannel shirt should be worn, and it and the blanket meet the requirements. There is no objection to the use of light flannels by men who find them comfortable, while in the cold season and in high lands, as at Baguio in Luzon, they may be much needed; but for most of the service to which our men have been subjected in the tropics they are a source of harm rather than of good. Light-weight cotton undershirts, with short sleeves, and muslin drawers not coming much below the knees are preferred. The clothing worn in the tropics requires frequent washing and frequent changing, and a good-sized laundry bill is a necessity. The clothing is usually sun-dried, and that is an important aid in destroying germs on it. Most native wash-men do not boil it, but, if feasible, they should be required to do so.

The campaign hat, as previously stated, is an excellent article for field use, but it should be well ventilated by openings in the sides, and should be worn in such a manner as to preserve a large air-space above the head.

The service cap offers very little protection from either heat or light, and is an unsuitable form of headgear for the tropics. It should be superseded for garrison use there by the campaign hat or a helmet, the latter of pith

or cork and with a ventilated sweatband and crown. Much has been said and written about the value of protection from the actinic or invisible rays of the sun, and helmets with an interlining of metal foil, and hat linings, underclothing, and spine-protectors of black, red, or orange material have been advocated as means of protection from them. Observation and experiment indicate that the main causes, other than infectious diseases, of tropical invalidism and discomfort are heat and humidity, and that, with due care in regard to these, the effects of actinic rays are practically negligible. In fact, it is the writer's opinion and observation that persons much in the sun are apt to fare better, except as regards infectious diseases, than those who remain much indoors, possibly because the former get more exercise.

The evil effects ascribed to the actinic rays are principally those manifesting themselves as functional nervous disorders. Such disorders are notoriously hard to trace to a definite cause, and, on the other hand, the sufferers from them are the most favorable subjects for treatment by mental suggestion. Therefore, the fact that a number of such sufferers are benefited by the use of red underclothing is not conclusive evidence that their ills were caused by actinic rays.

Shoes should always be worn in the tropics as a protection against infections. Comfort and fit should be considered as elsewhere, but because it is comfortable to go barefooted is not sufficient reason for doing it. One of the greatest causes of sickness and debility in the tropics is the hookworm, and as it usually gains entrance to the body through the skin of the feet, the general use of shoes is looked upon as an important

method of protection against it. Plague infection usually occurs through flea-bites on the feet and legs. Other infections occur in the same way; and the subject will be discussed at greater length in another chapter. Shoes and leggings also protect against leeches, ticks, mosquitoes, and other insects.

Exercise. Because of the heat, the relative cheapness of native servants, and his comparative wealth, the American is apt to neglect outdoor exercise in the tropics. It is very important that he should not do this, as abundant experience has shown that exercise lessens the liability to the nervous breakdowns that constitute one of the chief causes of invaliding from the tropics. It is desirable that the glare and heat of midday be avoided as times for such exercise, the early morning or the evening being preferred. The exercise should be incidental to interesting work or play. Tennis, polo, football, horseback-riding, and hunting are excellent forms. Marching is also good if the men are interested and cheerful. After the exercise, which should be sufficiently violent to produce a good sweat, the body should be bathed, well rubbed down, and dry clothing put on. Swimming is also a good form of exercise and one that should be encouraged, as every soldier should be a good swimmer.

With proper precautions as to exposure to the sun, the prevention of chill from wet clothing, and the avoidance of great fatigue, it is thought that exercise will do only good. Many white men in the tropics suffer from lack of it, very few, and they are usually persons already diseased, from excess. Its value lies in the promotion of the active functioning of the skin, liver, and other organs of waste elimination, and the resulting

improved nervous control, rather than in increase of muscular strength. Without exercise, alcohol, tobacco, and excesses in food are all doubly harmful.

Bathing. Because of the freer perspiration and the greater liability to skin diseases in the tropics, more frequent baths and changes of clothing are necessary than in temperate regions. The bath-water should not be sufficiently cold to produce shock or chill, but as such water cannot usually be obtained in the tropics, that feature need not require much consideration. Persons who have suffered from malaria or dysentery or other intestinal troubles should use tepid or warm water. It should be remembered that typhoid, dysentery, cholera, and certain infestations with animal parasites may be contracted by bathing in polluted streams or ponds, and such places should therefore be avoided. Whatever the source of the water, care should be taken that it does not get into the mouth and so carry infection. After the bath the body should be thoroughly dried, particular attention being paid to the arm-pits, crotch, and groins, and, if these parts sweat profusely, it is well to dabble them with some antiseptic solution and then dry them again, after which they may be dusted with talcum powder. Fresh and dry underclothing must be then donned. If prickly-heat eruptions are present or appear easily, a weak formalin solution, about one teaspoonful of formalin to a pint or a quart of water, may be used to sponge the body after it is washed and before drying. It is thought that the measures here advised are as good as are known for the prevention of the prickly heat, small boils, chafing, and "dhobie itch" or ringworms that cause so much annoyance and irritation in the tropics. In addition, it

should be remembered that some of these affections are contagious, and contact with persons having them should be avoided. Soldiers occasionally borrow articles of clothing from one another, and that is another method of spreading skin diseases. In Japan it is still a rather common custom for many people to bathe in the same tub or tankful of water, and that probably accounts for much of the abundant skin disease seen in that country. Such a practice, though economical of fuel and water, is to be avoided.

Sexual hygiene. The heat, the bright light, the new and strange environment, the native habits of both dress and conduct, unite to stimulate and excite the sexual desires of the new-comer in the tropics, while his money and the native habits, poverty, and views of morality, constitute a set of circumstances enabling him to gratify them. In consequence he is apt to indulge in such sexual excesses as impair his nervous control, unless, as is frequently the case, he is soon or often checked by venereal disease. Later, when he becomes debilitated by his excesses or by other causes, his sexual vigor fails and he begins to worry about that, thus aggravating and accentuating his trouble. Nothing that is equally harmless so profoundly affects the mind of the average young man as the loss, even though it be temporary, of his sexual vigor, and nothing so prolongs and aggravates that loss as continual brooding over it; so in this combination we have the making of neurasthenia and melancholia. Each man should know that his sexual needs are not greater in the tropics than elsewhere, that sexual or other excesses may bring about nervous exhaustion and temporary loss of sexual power, and that the best rules in the tropics, as else-

where, are: (1) sexual continence; (2) avoidance of obscenity and indecency; (3) cleanliness of the genitals; (4) complete avoidance of thought or handling of them except for legitimate and proper purposes.

Police and cleanliness. The necessity for thorough policing and cleanliness of houses and grounds is even more important in the tropics than elsewhere, because of the greater prevalence of vermin and of vermin-borne diseases. Malaria, yellow fever, dengue, plague, and other insect-borne diseases, occur principally in the tropics, and are best avoided by such methods of policing as do away with the feeding or breeding places of the insects carrying them. In addition, roaches and ants abound in numbers and with a persistency not seen elsewhere, and, as they run impartially in water-closets and food-chests, it is easily conceivable that they may transmit disease. Rats and mice constitute not only an annoyance but also a great and positive source of danger, because it is among them that epidemics of plague begin, and it is from such rat epidemics that those among people take their origin. Parasitic skin affections prevail very widely among persons, domestic animals, and fowls, and it is partly by cleanliness of habitation that we escape them.

All the usual sanitary precautions as to cleanliness, plumbing, and good policing are to be observed in the tropics as elsewhere; but additional care must be given to all standing water both inside the house and out, to prevent mosquitoes breeding in it. Such collections should not be allowed if they can be avoided. If allowed to exist, the water should be completely emptied and renewed once in four or five days at most, or should be kept covered with a film of mineral oil, which can be

renewed at like intervals. Ponds or other large collections should be stocked with fish, and the general precautions against mosquitoes, to be outlined later, should be observed. Mosquito-proof houses have proved of great benefit in the prevention of mosquito-borne diseases in the Canal Zone, as well as adding very greatly to the comfort of life there. That they are not universally used in malarious countries is a misfortune where it is not a reproach.

VERY COLD CLIMATES

The principal sanitary dangers menacing the dwellers in very cold climates, aside from lack of food and other things outside of our present consideration, arise from exposure to cold, resulting in frost-bite or freezing, from poor ventilation, from too intimate association with diseased persons or animals, from improper food or lack of fresh food. Infectious diseases are less numerous than elsewhere, as their germs do not find such favorable surroundings in which to grow, and there are fewer persons to harbor and distribute them.

Air. The outdoor air of arctic regions is purer and freer from disease-producing organisms than that of other regions. Man-polluted air is as dangerous there, however, as elsewhere. As ventilation and heating are, from a sanitary standpoint, inseparable, and, as free ventilation makes heating more difficult because of the greater volume of air that must be warmed, it may be understood at once that the natural tendency in an arctic climate is to have poor ventilation. Every increase in ventilation lets in cold and allows heat to escape, and the discomfort of this is more acutely and keenly felt than that due to foul air; so the effort to

keep warm may cause the air to become vile. As animal heat helps materially to warm a crowded space, and as crowding lessens the consumption of fuel, man and dogs, sick and well, are thrown into close contact. If one man in a crowded, ill-ventilated room has tuberculosis, diphtheria, tonsillitis, measles, smallpox, or other contagious malady, the contagium or poison is so concentrated as to make all present unusually liable to contract the disease.

Ventilation, therefore, should be as free as possible, care being taken to warm the incoming air, as by allowing the air to enter through a tube or tunnel opening under or about the stove. Should the air enter unwarmed it will cause such condensation of moisture as to make the hut damp. Crowding should be avoided, and as much time as possible be spent in the open. Particularly should intimate association in crowded rooms with sick persons be avoided. The intimate contact with sick and with animals is also productive of disease in other ways than that indicated above. A man having gonorrhœa or syphilis is in such circumstances much more apt to infect innocently and unknowingly those about him than he would be under other conditions. Echinococcus disease, due to infestation with a certain dog tapeworm, is almost limited to persons brought into such intimate contact with dogs as is here mentioned. Cleanliness is almost impossible under such conditions, and wounds are thereby very apt to become infected.

Water. A pure water-supply is not such a rarity in the arctics as in the tropics, both because pathogenic germs do not flourish in arctic temperatures and because men are less numerous as sources of pollution.

The danger of pollution of a supply is greatest in the spring and summer, when melting snow may wash into it the excrement that was scattered in the neighborhood during the very cold weather. Excrement is apt to be so scattered, for the reasons that other disposal may be more troublesome and that snow and freezing prevent its constituting a nuisance to the nose and eyes. Especial care should be exercised to prevent anything of the kind, and drinking-water should always be taken from points above any possibility of such contamination. Attempts should not be made, particularly on marches, to quench thirst with snow or ice, as they detract from the local and general heat of the body, and are liable to irritate the mouth and throat. Snow and ice may furnish the water-supply, but they must be melted and the water heated, when it may be profitably used in making tea, which is then refreshing, comforting, and stimulating, and adds to the warmth of the body.

Food. The food-supply of the arctics consists largely of canned goods, and may be quite generous. Every effort should be made to supplement that diet with fresh articles, whether of animal or vegetable origin, as scurvy is otherwise apt to make its appearance. This disease is due to the deficiency of some principle or "vitamine" contained in both meats and vegetables, which is destroyed by overheating, by long storage or by ripening and drying of the vegetables. For instance it can be caused in guinea pigs by a diet of bread and dried mongo beans, while a diet of bread and *sprouted* mongo beans protects them from it. The Scott Antarctic expedition avoided scurvy by the abundant use of the fresh or frozen meat of gulls, penguins, and seals, and the surgeon especially praises seal meat as an anti-scorbutic.

Because of the necessity of greater bodily heat-production in the arctics, more food is required, and, as meat and fat give rise to more heat during their oxidation, and as they are also more readily obtained, it is in them that the increase should be made. This need is recognized by the Government, and is met by an increase in the ration for troops serving in Alaska. Where game or fish are obtainable they should be used to supplement the ration. The methods of preparing the food are not essentially different from those used elsewhere. Foods should be served hot, and the heat of the body so conserved.

Alcohol. Alcohol should not be used in the arctics except as a drug, as it increases heat-radiation and loss. Particular care should be taken that it is not used during the period of exposure to cold, as that is the time when loss of heat is to be especially avoided. If used at all, it should be after the period of exposure, when the body is chilled and the surroundings warm and comfortable. In such circumstances it may be of considerable value, but its routine use should not be practiced.

Clothing. Fur, feathers, and wool as conservators of heat, and canvas and leather as protection from wind, constitute the main clothing-supply and bodily protection in the arctics. Fur, leather, and canvas, with the exception of shoes, are for use out-of-doors only, wool for general wear both indoors and out, while feathers or down are used in bedding. Extreme cold is nearly always dry, and may therefore cause less suffering than higher temperatures when the air is moist. Wind of course greatly increases the suffering and the danger from either dry or wet cold. The reason that

fur, feathers, and wool make such warm clothing is twofold; they are themselves poor conductors of heat, and they contain in their interstices a large amount of air, another poor conductor. For the latter reason a multiplicity of light garments is warmer than the same amount of material woven into one heavy garment, and cotton or silk wadding may be used also with good results. It is because they prevent the displacement of the warmed non-conducting layer of air within the clothing that leather or close-woven canvas affords such excellent protection against wind.

Fur caps and gloves, blanket-lined canvas boots, canvas overcoats lined with blanket or sheepskin, woolen outer and under clothing, woolen socks, oiled shoes, felt overshoes, and canvas leggings are issued for very cold service, and in a few far northern posts buffalo coats are furnished for use by men on guard. By proper use, these articles can be made to furnish adequate protection against any cold that is likely to be encountered. The parts most apt to suffer from cold are those most exposed and having the weakest circulation, such as the nose and cheeks, the ears, hands, and feet. The fur cap protects the head and ears, but not the neck and face. It should therefore be used with the overcoat collar turned up, or with the hood of the coat, in very cold weather. The blanket-lined canvas hood covers the neck and part of the face and therefore affords better protection. A veil or a strip of cloth may also be worn across the lower part of the face if necessary. The fur gloves adequately protect the hands except in the most extreme cold or in cases of long exposure. If necessary, woolen gloves may be worn beneath them. When, in spite of them, the hands become numb and cold, they

should be beaten or exercised to warm them. For work not requiring the use of individual fingers, woolen mittens under canvas afford good protection for the hands. Care should be exercised about removing the warm hand from its glove to do delicate work in the cold. A soldier has been known to have both hands frost-bitten because he removed his gloves in the wind and in a temperature of 40° below zero F. long enough to adjust his saddle. The feet are easily kept warm during walking if the Government issues of footwear are properly used, but when men are riding and not using the feet, or when snowshoeing and the feet are bound so tightly that the circulation is interfered with, the problem is more difficult. Except in wet weather, the foot-covering should not be impermeable, as the feet when comfortably warm are apt to perspire, and such a covering as a rubber shoe causes the perspiration to condense against it and to be frozen there, so that the foot is almost or actually in contact with ice. An oiled shoe is less objectionable, as it does permit the vapor to escape, in part at least. In very dry cold, however, a felt shoe, or two or more pairs of woolen socks with canvas or soft leather moccasins, may be better still. Fur-lined boots or stockings are very warm. Surgeon Atkinson, of the Scott expedition, says:

> It was essential each night on camping to change the footgear immediately, the socks having become saturated with perspiration. Special socks of very thick woolen texture were kept for sleeping in, and they remained practically dry. Over them was worn a loose fitting bag of some fur. On changing the socks they were pinned together with a safety pin and hung outside. If there was a good sun, by next morning they were completely dry and comfortable.

The remainder of this chapter is made up of extracts from Surgeon Atkinson's account of the antarctic experiences of the Scott expedition:

Frost-bite varied in degree from the loss of a superficial patch of skin to the loss of parts of limbs.

Frost-bites of first degree. In the open, it was quite a common and even laughable experience to see one's companion's nose or cheek with a patch of white upon it. He, at the time, was quite unconscious that anything was wrong. When warned, he removed the warm hand from his mit and placed it upon the offending part. At the same time, if there was any wind, he would turn away from it. After a minute or so, with a slight tingling sensation, the circulation returned to the part, and in the course of a day or so there was a very small loss of quite superficial skin. Parts which had been attacked by frost-bite became necessarily more subject and also, luckily, gave warning. If a wind sprang up, one felt a sting like that of a bee, and knew immediately that the nose or cheek was attacked, and took measures to bring the circulation back.

Frost-bites of second degree. Frost-bite of the second degree caused blisters, varying depths of substance being implicated. It was quite common after any cold sledging trip for one's fingers to be bulbous at the end. This was due to blisters of varying sizes, and was caused by exposure to cold, and also by handling cold metal objects, like the cooker and Primus. These blisters were of no importance, and on return they were pricked; after some time the skin was replaced and the fingers became normal again. . . . Another effect of continually touching cold metal objects was that the fingers never quite reached the stage of blistering, but the skin became hard and thickened, so much so that one was unable to appreciate such an object as a match between the fingers. The hardened skin always peeled off after we had been back in the hut for a time.

Frost-bites of third degree. This degree, besides causing blisters, caused actual loss of substance by gangrene. After exposure the onset of gangrene came on at a varying period. It was never immediate, and varied from a fortnight to three

weeks. The blister contained an evil-smelling, sanguineous fluid, and beneath it was a dark, fungating patch. A line of demarcation formed after a varying period, and then sloughing of the affected part followed. . . .

The only treatment that the majority of frost-bites needed was the application of a warm hand to the affected part. The application of snow is probably of use in temperate climates, but where the snow is at the same temperature as the air it is impossible to do this. Also, the snow in the Antarctic is composed of hard, sugary grains, and the effect of rubbing this upon the affected parts would probably be more serious than the frost-bite itself. It was always as well to be certain that one had no frost-bites before returning to the warm hut.

The effect of food upon the circulation was very well marked. After one had been under way pulling a sledge for four or five hours, if there was any wind, one started feeling cold, and then began to be frost-bitten. On camping and having something hot to drink the effect was immediate. One felt the heart begin to beat strongly and powerfully, and gradually a glow spread downward into one's feet and generally over one's body. On cold days, when the temperature was below –40° F., if the air were still one was not at all subject to frost-bite, but immediately a slight or strong breeze sprang up with a rise of temperature one's face became affected. The amount of evaporation on a windy day compared with that of a still day is about the proportion of five to one. After washing and removing fatty substances from the face one was more susceptible to frost-bite.

Effect of concentrated food after man-hauling for more than two months. All parties noticed after being out for more than two months man-hauling that they got practically no satisfaction from the concentrated food. One became exactly like a machine. With a certain quality of food it was possible to go on for a certain time and do a certain amount of work. With a little extra food a little more work could be done. With the ration that was provided, after a time one started feeding on one's tissues. Emaciation was extreme on the return from the Southern journey, and the effects of cold were naturally

much more severe in this state. Owing to the fatty nature of the food defecation was extremely easy, and one reacted in this way immediately to any increase of food.

The monotony of travelling over a dead white surface on overcast days, when no horizon was visible, was extremely marked. It can only be likened to intellectual starvation.

The effect of a cold trip upon the constitution was extremely well marked, though with nothing definite. In any trip extending up to a week, where the temperature was continuously below -40° F., the men returned in an extremely low state. During this time one never, while in the sleeping bag, got any conscious sleep, and once or twice there were well-marked cases of men sleeping while actually under way. This want of sleep caused a general lowering of the constitution, and the lassitude after a cold sledging journey is a thing always to be remembered.

Snow-Blindness. *Snow-blindness on bright days.* If one did not wear glasses, even for so short a time as half an hour, on those bright days, one was practically certain to have an attack of snow-blindness. The eye felt perfectly well while at work in the open, but the initial symptom was always noticed upon entering a tent where a Primus stove was alight. The attack began with a feeling of grains of sand in the eye. There was marked spasm, conjunctivitis, and weeping. Photophobia was well marked. This lasted for a varying period, the eye being irritable for as long as two days, even with treatment. The conjunctiva was congested and swollen, and the condition one of extreme discomfort. It was a pure conjunctivitis and due entirely to the strength of the illumination. . . . When away sledging the tea leaves used to be saved after luncheon and, made into a rough poultice, were worn over the affected eye under the snow goggles. This always produced a greater degree of comfort and was beneficial.

Snow-blindness on overcast days with strong and diffused light. On these days there was want of contrast, and the diffusion of light was caused by refraction and reflection of light from the surfaces of minute ice crystals, which were continuously falling. The light therefore came from all directions equally. It was impossible to distinguish the difference be-

tween foreground and horizon. One's appreciation of whereabouts was practically limited to the skis on one's feet. Contrast was entirely absent because of want of shadow, and, as an instance, it was possible to be standing within arm's length of a snow cairn nine feet high, and for the cairn to be invisible. Eye-strain was continuous, the eye striving to make out whether the foot was being placed on an even surface. It was impossible to appreciate any inequalities, such as sastrugi. At the same time the illumination was intense. The result of these two conditions was to cause conjunctivitis plus diplopia from the tiring of the eye muscles. The diplopia was exceedingly marked, and lasted for some considerable time. It was impossible to accommodate for any object, and it was only on going into the tent or seeking any dark object near that the diplopia was realized.

Snow-blindness on dull, overcast days. On such days the effect was entirely one of eye-strain. Although the eyeball was congested to a varying degree, the main effect was due to eye-strain, and diplopia was much more marked. The want of contrast was the same, but the intensity of illumination was absent.

The deductions from the above are that snow-blindness is in part eye-strain, and in part due to the actual effect of light.

For the *prevention of snow-blindness*, leather goggles with amber glasses are recommended. Care must be taken that no metal comes in contact with the skin, that the glass is well away from the eye, and that the entrance of light from the sides is excluded. Eskimo "snow-eyes," or wooden spectacles with slit-like openings for vision, are said to be excellent. The use of veiling across the eyes, and the practice of marching with the eyes fixed on the back of the man ahead, the leader being changed at short intervals, are at times helpful.

PART II

THE CAUSES OF DISEASE

He discovereth deep things out of darkness, and bringeth out to light the shadow of death. JOB 12 : 22

CHAPTER VIII

THE REMOTE OR PREDISPOSING CAUSES OF DISEASE

For our purposes it may be assumed that most of the diseases with which we are concerned are due to animal or vegetable parasites; but not every man exposed to infection by such parasites contracts the diseases caused by them. A special predisposition or liability is necessary, otherwise everybody would have tuberculosis, the entire army at Chickamauga in 1898 would have had typhoid fever, and all physicians would die of infectious diseases within a short time after entering upon their profession. This matter of liability or immunity to diseases is one of the most interesting, complicated, and important in the whole realm of medicine, and many of the world's greatest thinkers and investigators find it worthy of their highest efforts and constant attention. It is the purpose of this chapter to deal with these questions in some elementary aspects that should be known by the company officer, in a practical and simple way, without technicalities.

Heredity. One of the most important of the factors concerned in predisposition to disease is heredity. Every man inherits from his ancestry something that renders him liable to tuberculosis, but immune to rinderpest and chicken-cholera. He possesses in a degree not possessed by any other known creature a liability to malaria, syphilis, gonorrhœa, yellow fever, cholera, smallpox, and other diseases, while he shares with many other animals his susceptibility to tuberculosis,

suppuration, plague, and anthrax, and at the same time he is not at all subject to some diseases that are very fatal to his domestic animals.

In addition to its influence in this general sense, heredity has long been credited with great influence in predisposing certain families or individuals to certain diseases. Consumption was long looked upon as a hereditary disease, but, with our more complete knowledge as to its nature, the tendency is now to regard its appearance and persistence in families as an evidence of familiar contagion rather than of heredity. In the case of cancer, another disease prone to "run in families," the same explanation is now frequently advanced, though no germ-cause is known for the disease. The influence of heredity, though still considered weighty, is not now so much emphasized as formerly as a cause of insanity. In all these diseases, however, it is still contended that a predisposition, a type of tissues endowed with resisting powers below the normal, is inherited, even if the disease has an extraneous cause. Disease can at times be born with the child, and not manifest itself until later, the actual disease germ being present in the body all the time. Syphilis is the ailment most often showing this. Other diseases, such as typhoid and smallpox, may be contracted in the uterus, and the child may be born sick. It is probable that sometimes disease may be suffered and recovered from in the mother's womb, and the attack confer immunity through later life.

Certain persons appear to possess all their lives an immunity to certain diseases, never contracting them in spite of frequent and direct exposure.[1]

[1] Captain C. F. Craig and the writer were quite unable to infect

Certain nervous affections have no known cause but heredity, the disease appearing in the affected family with great regularity. "Bleeders," persons who bleed excessively or fatally from very trifling injuries, in most instances inherit the tendency, and in a curious way, as it usually descends only *through* females to manifest itself *in* males. The drink habit is often spoken of as inherited, but this is probably not the case. An unstable nervous system, which allows its possessor to fall more readily a victim to drink or other excesses, is inherited. It is common observation that types of body are inherited, that children look and are built like their parents, and it is but natural that they should be predisposed to the same diseases, so far as bodily conformation exercises any influence.

Types of body. That this does exercise an influence is indicated by the table quoted on page 5, as well as by popular belief. The common remark that such a man looks as though he might have apoplexy any day, or such another man will probably die of consumption, are based on facts long noted by physicians and the public. It is partly for the purpose of eliminating persons so predisposed to disease that the Government usually demands not only that each man shall be in good health at the time of his enlistment, but that he shall also conform to certain standards not having much bearing on his present efficiency.

Age. Certain diseases are known generally as those of childhood, as they are so rarely seen in persons beyond that age. Scarlet fever, measles, whooping-cough, and

certain individuals, who volunteered for the purpose, with dengue, using methods usually successful and injecting doses of infected blood many times as great as would be received in natural infections.

diphtheria may all occur at other stages of life, but it is with ever-decreasing frequency that they do so, and the phrase is, in general, correct. On the other hand, cancer, apoplexy, cataract, and several other troubles are so nearly confined to aged persons that they may be called diseases of old age. Certain infections are seen principally in early adult life, so that it is the young soldier that usually shows them in the military service. Among them we may mention typhoid, gonorrhœa, syphilis. The question of age is related to that of recklessness and folly, and it is partly for this reason that the young are in general more disposed than the old to infectious diseases. The prospects of recovery from an illness are also influenced by age. Pneumonia and injuries are much more serious in an old than in a young man. On the other hand, diabetes and epilepsy are not usually so serious in elderly persons as in children.

Personal peculiarity. Certain persons are born with peculiarities of person that render them particularly liable to certain diseases, and no adequate explanation can be offered for them. Some persons cannot eat fish, others strawberries, others eggs, without becoming sick. A large number of persons have such a susceptibility to the effects of certain pollens that they must leave their homes when these pollens are ripe, or suffer from hay fever. Some men suffer from asthma if they go about a stable or ride behind a horse, others are made sick or faint by the presence of a cat or the odor of its urine. Of two healthy men, one may suffer great discomfort after taking a tenth of a grain of iodide of potash, while the other can take three hundred times as much and not suffer at all. Many of these peculiarities are now believed to be examples of anaphylaxis, of

which mention will be made in the next chapter. It is quite probable that related phenomena influence the development and course of infectious diseases.

Mental states. Worry, fear, and homesickness strongly predispose to, if they do not actually cause, mental and nervous diseases. They also appear to predispose to infectious diseases, possibly by lowering the general resisting powers and influencing the circulation.

Training. The aphorisms of all languages recognize the value of training in almost any occupation or pursuit in life. Military authorities recognize it by the fact that they require the soldier to spend years in training. It is not less valuable in sanitary matters than elsewhere. The child or the man who is trained to reason, to obey, and to conduct himself properly, is in much less danger from infectious diseases in camp or elsewhere than is the reckless, disobedient, or headstrong individual who knows no law but his own will and appetite. It is the latter who drinks bad water, eats poor food, contracts venereal disease at each opportunity, urinates and defecates in forbidden places, avoids vaccination, seeks alcoholic indulgence, sleeps without his mosquito-net, spits on the floor, and is otherwise a source of much worry and mischief. It is because of this lack of training in hygiene that recruits are so apt to become sick when brought into camp, and, what is worse, to scatter their sickness in all directions. As training in hygiene increases among officers and men with increase of knowledge, the results show in the sick report, and it is not probable that the evil conditions of the camps of 1898 will ever be repeated in the camps of the regular army. Whether or not they will be repeated in large camps of volunteers

remains to be seen, but it is improbable, as we know how to prevent them and hope to be able to do so. It is also hoped that such epidemics of respiratory diseases as visited our camps and transports during the war with Germany may be avoidable in the future, but if the same apparent necessity for overcrowding exists it is feared that they may recur, though possibly less virulently. The fault is known, but it is less readily avoidable than those of the Spanish War.

Lack of training on the part of troops is a most important predisposing cause of disease in armies. It is the duty of all officers, of whatever rank or branch of the service, to endeavor to overcome this defect, for which they are mainly responsible. The fact that a man is ignorant or headstrong at the time of his enlistment does not justify his being so a year or three years later. Medical officers should be required to give lectures or other instruction, but the company officer should see that example and wise precept are so constantly before the minds of his men that hygienic living becomes a matter of habit.

Habits. Aside from habit in the large sense just used, many small and unimportant personal customs have an influence in predisposing to disease. Eating raw meat predisposes to infestation with trichinæ or with tapeworms, carelessness in hand-washing increases the liability to many infections and poisonings. The habit of going barefooted may be of very great importance in predisposing to plague and hookworm disease. Careless habits in the disposal of waste are responsible for so many sanitary ills as to make it evident that the main purpose of sanitary training is the establishment of proper habits.

Race. The influence of race as a predisposing factor of disease is closely related to that of heredity, habits, and environment, but race in itself exercises some influence. The reason for this is not always known, but in some instances it is probably due to long racial exposure to certain diseases, whereby only the more resistant strains or families survive. At other times it is probably the case that the disease in question may be uniformly incurred in childhood, and so confer protection through later life. Whatever the reason, Cubans and West African natives are less susceptible to yellow fever than Americans and Europeans. Jews are especially subject to diabetes, and negroes are much more apt than other peoples to suffer from keloid, a form of tumor.

Exposure. Exposure to inclemencies of weather predisposes to numerous diseases. Tonsillitis, pneumonia, rheumatism, and influenza are all germ-diseases, yet the frequency with which they are ascribed to wetting or cold shows that these influences are not without effect. The germs causing pneumonia, diphtheria, spinal meningitis, and tonsillitis may be present in the mouths or noses of healthy people and produce no symptoms, yet after exposure the person may sicken. Similarly, a person may carry the organisms of malaria or dysentery, and only become conscious that he is ill after wetting or chilling. There is a growing belief that nearly all tuberculosis infections are received in early life, and that the appearance of the disease only at a later period is due to a lowering of resistance at that time, whether by an attack of typhoid or measles, by hard work, poor food, exposure, or other cause.

Injury. Injury predisposes to very many diseases.

Pneumonia, meningitis, and typhoid, of general diseases, may follow injuries in such a manner as to appear related to them. Abscesses, kidney and liver troubles, and tumors may follow injuries that do not break the skin, while anthrax, erysipelas, most suppurations, "blood-poisoning," hospital gangrene, lockjaw, hydrophobia, and some other affections are preceded by breaks in the skin in nearly all instances, though these may be so small as not to be noticed at the time. It is through the wounds that the disease-producing organisms gain entrance to the body. In the strict sense it is also through wounds — insect bites — that malaria, yellow fever, plague, and sleeping sickness are transmitted. The great class of suppurations, however, are the principal diseases following injury, and the proper use of the first-aid packet for the purpose of preventing them has greatly reduced one of the horrors of war.

Injury may also act as a means of diffusing and generalizing an affection previously isolated and relatively harmless. It may rupture an abscess due to appendicitis, and so give rise to general and fatal peritonitis, or it may loosen the infected clot in an inflamed vein, and cause acute general "blood-poisoning."

Environment. As is shown in Part I of this book, the soldier's environment includes so much that it must exercise an influence in predisposing him to, or protecting him against, nearly all sorts of diseases. It is so large a matter that it cannot be adequately mentioned in a paragraph, and the whole subject of hygiene touches on it. The consideration of some phases of it occupies the remainder of this chapter.

City or country life. The greater prevalence of infectious diseases among men drawn to the draft army

from country districts, as compared with those from cities, has led to the suggestion that the immunity of city-bred men might be due to (*a*) the fact that they had acquired immunity as a result of attacks in childhood; (*b*) that the immunity is due to a selective elimination of susceptibles; or (*c*) that life in urban communities produces a general resistance to disease of which the observed resistance to measles, mumps, lobar pneumonia, cerebro-spinal meningitis, and scarlet fever are only special instances.

Occupation. There are quite a number of "occupation diseases," so called because their development depends on injury due to the employment of the individuals. Among such diseases may be mentioned writer's cramp, painter's colic, chimney-sweep's scrotum, housemaid's knee, and many others. During and after the Civil War a certain type of dilated and irritable heart was known as soldier's heart, and in the stress of a hard campaign many more cases may develop. In the early months of 1899, when the State troops were doing much hard marching in the Philippines, many such cases were seen. Very large numbers of them were found during the recent World War, being known in the British service as D.O.H., disordered heart action, in ours as irritable heart, "effort syndrome," etc. Other factors than overexertion are causes, factors such as nervous control, fear, overuse of tobacco, thyroid disturbances, and infection.

Occupation has a great effect in other and less obvious ways. Thus it may expose a soldier to mosquito bites and so predispose him to malaria, yellow fever, or dengue; it may put him on guard in a prison, where he will contract typhus or relapsing fever. Men work-

ing about stables are more apt than others to suffer from lockjaw after wounds, as the germ occurs in horse-manure. Occupations involving the breathing of much dust, such as marble-cutting, scissors-grinding, and some weaving, predispose to tuberculosis. Sedentary occupations may impair digestion, allow muscles to atophy, and cause hemorrhoids. Callings involving great strains or exertion predispose to diseases of the heart and blood-vessels. It is stated that the majority of Japanese jinricksha men are dead or invalids from circulatory diseases before they attain the age of forty. Many occupations predispose to chemical poisoning, such as poisoning by lead or wood alcohol. Certain work on munitions and the "doping" of cloth for airplanes subjected many war workers to hazards previously little known. Occupations causing much worry or nervous strain predispose to nervous exhaustion. Overwork in almost any calling may predispose to disease, either by lowering or exhausting the general resisting powers of the body, or by exhausting the nervous supply. Fatigue predisposes powerfully to pneumonia during epidemic prevalence of influenza.

Air. The quality of the air-supply is very important as predisposing to disease, by its temperature, dryness, or purity. Too great heat, especially if moist, causes much discomfort and may result in heat-exhaustion, heat-stroke, and death. Rooms that are too hot cause the men to sweat and to expose themselves unduly to cold or draughts, which may result in congestions of the lungs or kidneys. Rooms that are too cold allow the body to become chilled on the surface and congested internally, making easy the development of coughs, sore throat, and other troubles. In

barracks, however, such troubles are usually more closely related to foulness and contamination of the air than to its temperature. One case of sore throat in a squad-room may suffice to contaminate the air and expose every man in the room to disease if the ventilation is poor. This condition is aggravated with every increase in crowding. Carbon dioxide and other waste-products of the body may also make the air poisonous without considering infection.

Foggy or damp air predisposes somewhat to rheumatism. That which is too dry causes dryness and irritation of the respiratory surfaces. Dusty air introduces many infections, among them tuberculosis, and it is for this reason that spitting on floors or streets is very dangerous. The spit dries and is pulverized, and eventually becomes dust, in which condition it may be blown or inhaled into sound noses or throats, carrying with it the disease-producing germs. Dust-laden air is responsible for many more "colds" than is cold itself.

Water. The use of contaminated water predisposes, of course, to water-borne infections. In addition, the use of very hard water or of water containing chemicals may so disturb the digestive organs as to make infection easier. Excessive water-drinking disturbs the digestion and causes unnecessarily profuse sweating and urination; deficiency of it causes irritation of the kidneys and bladder, constipation, and general insufficiency of waste elimination. Greater insufficiency of course causes direct suffering from thirst.

Food. Aside from the very numerous infections conveyed by uncooked or improperly cooked foods, the kind, amount, and preparation of the articles used have so great an influence on health as to make the

subjects of catering and cookery worthy of the company officer's best thought. He should learn what foods are good, their digestibility, food-values, cost, and the amounts to be furnished. The method of preparation should be such as to make them attractive and digestible. The ration forms an excellent basis.

Excess of food predisposes to stomach and intestinal disorders, to gout, obesity, vascular and kidney diseases, and to various forms of auto-intoxication, or self-poisoning by waste products. Insufficiency of proper food leads to weakness, loss of flesh and a lessened resistance, that renders infections more easy. Great epidemics of typhus and relapsing fever have followed famine and deprivation so many times as to earn for them the title of famine fevers, and our present knowledge that they are louse-borne enables us to appreciate the influence of misery in lowering physical and moral tone.

Alcohol. Alcohol is the direct cause of such diseases as delirium tremens, alcoholic neuritis, and gastric catarrh; but it is also a predisposing cause of many other diseases. It predisposes to infections, both by making its user careless in regard to them and by lowering the resisting powers. Drunkards are especially subject to pneumonia, and are also especially unfavorable subjects for that disease. The chronic gastric catarrh of the old alcoholic may make him an easy victim for cholera or typhoid. Alcohol predisposes to heat-exhaustion in hot and to freezing in cold climates.

Clothing. Insufficient or excessive clothing may predispose to disease as do heat and cold. Insufficient covering in the tropics may lead to severe sunburn, or, if of the head or spine, predispose to heat-stroke. Lack of foot-covering not only leads to injury of the

feet, but predisposes to diseases that usually enter through the skin of the feet, including hookworm disease, chiggers, Guinea worm, and plague. Insufficient clothing may also predispose to mosquito-borne diseases. Excessive clothing may predispose to heat-stroke, exhaustion, and diarrhœa, and this is especially true when men are turned out for inspection or drill in too heavy uniforms.

Bathing. Warm baths, if followed by exposure or chilling, may predispose to disease, as may cold ones in persons who do not react promptly. Insufficient bathing predisposes to skin diseases, especially in hot countries; bathing in polluted waters, to water-borne infections. In addition to typhoid, dysentery, cholera, and common intestinal worms, it is known that *schistosomum* disease — infestation with a worm that lives in the veins of the liver, and causes bleeding and other serious bowel and bladder symptoms — may occur during bathing, the young parasites entering through the skin. This disease is widespread in Africa, and varieties of it are seen in the West Indies and the Philippines, so that it may yet assume importance with us. It affected many British soldiers in Egypt during the World War.

The use of dirty water also predisposes to skin diseases, as noted in regard to the oft-bathing Japanese. The exposure incident to bathing in streams may increase the liability to diseases conveyed by mosquitoes and other insects.

Sleeping. Natural sleep in proper amounts is an important factor in the prevention of disease; the lack of it causes weakness, exhaustion, and depression that render infection and injury easy matters. Insufficient

sleep for a long period of time causes nervous disorders and predisposes to insanity. Sleeping in improper surroundings may greatly increase the liability to disease through chilling, wetting, exposure to mosquito bites, and in other ways. Sleeping in close contact with persons suffering from certain contagious diseases would strongly predispose to them, as would sleeping in the beds or clothing of such persons.

Police. Poor sanitary police is a feature of poor military training, and predisposes to all of the epidemic forms of infectious diseases. It does this by allowing infected dust and papers to blow about and pollute the air, by allowing soil and water contamination, by leaving or providing breeding-places and food for flies, fleas, mosquitoes, rats, and other vermin, and by failure to remove sources of infection. In these ways it encourages the development of typhoid, cholera, dysentery, yellow fever, plague, pneumonia, influenza, tuberculosis, and other diseases.

By attention to police and general cleanliness of persons, houses, and neighborhoods some diseases that formerly occurred in great epidemics have been almost banished from civilized countries. Typhus and relapsing fever were considered striking examples of this, but the experience of recent years in the Balkans, Russia, Poland, and in Austrian, Serbian, and German prison camps, shows clearly that when want, misery, and filth become sufficiently pressing lousiness follows and these diseases spread rapidly and widely when infection is introduced.

As the best police is possible only when all unite in striving for it, it is essential that line officers and enlisted men should become interested in the sanitary

importance of the question, and should look on good policing as a source of pride, comfort, safety, and efficiency.

Camp-sites. A poor camp-site may constitute a predisposing cause to many kinds of disease. It may expose the men to fog, unnecessary dampness, wind and cold, or to dust and heat, to mosquitoes, flies, fleas, bad water, or contaminated soil, and through these factors promote the development of the worst camp-diseases. While it is highly desirable, therefore, to select as good camp-sites as can be obtained, it must ever be borne in mind that proper sanitary precautions may nullify the evil effects of a bad site, and that neglect of them is almost certain to destroy the value of a good one. Polluted sites, those that have been much used by troops, and those that expose the men to bad water and disease-bearing insects are particularly to be avoided, as these factors predispose so strongly to various diseases that only the best trained and disciplined troops may come off unharmed.

Presence of disease. Practically every case of infectious disease is derived from some other one, and it is therefore obvious that the existence of one case constitutes a factor predisposing to more. One man with typhoid, cholera, smallpox, or plague, in a camp, constitutes a danger to the entire command, and this fact is so well recognized in these and other diseases that it forms the basis of the entire system of quarantine and isolation. The origin of individual cases of infectious diseases may be difficult to trace, the typhoid-carrier, the unsuspected syphilitic, or the man with a slight diphtheria, not even realizing that he is sick, and unknowingly spreading disease broadcast. One disease

may predispose to the development of another or to new manifestations that are spoken of as new diseases. Thus blood-poisoning, gonorrhœa, typhoid, and, more particularly, acute articular rheumatism, predispose to valvular heart-disease, syphilis to certain affections of the nervous system and to aneurysm, diphtheria to varying forms of paralysis, and amœbic dysentery to abscess of the liver. The influence of measles and influenza in predisposing to pneumonia was strikingly shown in all our camps during the World War.

CHAPTER IX

THE IMMEDIATE OR EXCITING CAUSES OF DISEASE

THE immediate or exciting causes of some diseases, among which may be mentioned such important ones as scarlet fever, measles, yellow fever, and typhus, are unknown, but those that are known are so numerous and of such varied character that they could not possibly be discussed in this chapter, even if it were desirable that they should be. We will therefore omit all discussion of the causes of large and important groups of diseases, and consider only briefly the various classes of disease-producing factors which it seems it would be interesting or profitable for the company officer to know. Numerous as they are, such factors may be gathered into a few groups.

Mechanical. Of these groups, the first to be considered is that of mechanical causes, and, of such, *traumatism* or violence is probably the most important. Like the other components of this group, it may predispose to disease, but it is also the direct or exciting cause of many ills, among which we may class practically all varieties and instances of wounds, from the slightest abrasion to the most extensive shell-wound, fractures, dislocations, and bruises. Concussion, laceration, or rupture of internal organs, such as the brain, spinal cord, liver, kidneys, stomach, intestines, or bladder, may result from blows or other injuries that cause no break in the skin, or even, in rare instances, leave no external mark. At times the violence may be slight in

degree, and apparently out of all proportion to the resulting damage. Thus, a relatively slight blow on the chin may be so directly transmitted to the brain, and so jar and shake it, as to cause immediate and deep unconsciousness; or a blow over a distended stomach or bladder may rupture it and cause death, to the great surprise of all witnesses. Or the evil effects of the injury may not be manifested at once. A knee or hip, for instance, may be injured and give rise to no symptoms at the time, but later cause prolonged suffering or lameness; or a man may receive a severe blow on the head or the abdomen, and continue at his work all day, yet he may have received an injury from which he will die in a few days. Officers should, therefore, exercise much care and forbearance before they pronounce a man a malingerer because some accident from which he suffered appeared trivial or harmless. Violence may be so transmitted as to manifest its effects on a distant part. Thus a man may fall from a height and land on his feet, and yet fracture his skull; or he may fall on his hands and fracture his collar-bone; or he may receive a blow on the right side of the head and suffer a laceration of the left side of the brain. As the manifestations of violence may be almost infinite in variety, so may its effects. *Pressure* may also cause disease in a variety of ways. Applied to the feet it may cause deformity, bunions, or corns; to the waist, displacement of internal organs; to a nerve, as by a bullet or a bone-fragment, paralysis or great pain; applied to a blood-vessel, it may cause ulceration and rupture, with fatal bleeding, or it may cut off the blood-supply of the part to which the vessel runs, and cause gangrene or death.

Heat and *cold*, besides predisposing to disease, as shown in the preceding chapter, may directly cause injuries varying from the slight reddening of the mildest burn or chilblain to the loss of entire limbs, or of life itself. They, as well as violence and pressure, in addition to the immediate damage done, may cause lifelong suffering or deformity, from the formation or contraction of large scars, or by means of secondary infections.

Increase or *diminution* of *atmospheric pressure* may cause disease or death, the former in divers or caisson-workers, the latter in mountain-climbers or balloonists. The discovery that many men either lost consciousness or had their nervous and muscular control greatly impaired by ascending to great heights in airplanes, that many accidents were due to this cause, and that inhalations of oxygen begun before the individual reaches the altitude dangerous for him prevent these symptoms, has saved many lives and proved very important in aviation. It must be added, though, that the remedy proves that the trouble is due to diminution of the oxygen-supply, rather than to diminished air pressure. In the case of increased pressure, the trouble most often comes from too sudden return to normal pressure, which allows the liberation of nitrogen gas in the blood.

Electricity may cause disorders varying from slight pain or nervous disturbance to deep burning or sudden death.

Mechanical injuries not usually thought of as such are exemplified by the rashes or irritations due to handling or contact with some *caterpillars* or *moths*, and are caused by the introduction and retention in the skin of the minute barbed hairs that partly cover the creatures.

Chemical. The group of chemicals that cause disease or death is very large and embraces practically all poisons. They may occur in any form, gaseous, liquid, or solid, and may enter the body in any way, as by inhalation, by mouth, by the rectum, through the skin, or through wounds.

Gaseous poisons usually enter the system by inhalation. Those most commonly causing trouble are carbon dioxide, water gas, coal or charcoal gas, or carbon monoxide. These and other gases may produce death without occasioning great suffering. Another group, including formalin, ammonia, chlorine, and sulphurous fumes, cause marked irritation of the respiratory tract and excite efforts at escape, so that they are, in that respect, less dangerous. Abundant experience with them in the war against the Germans has made familiar the poisonous effects of phosgene, "mustard gas," and other gases not named above, and it is probable that they will continue to be used in war because of their effectiveness. The gas-mask will therefore remain of great hygienic and military value. Certain others, such as some compounds of arsenic or phosphorus, may cause poisoning by inhalation in small amounts, and be very difficult to trace. Chloroform and ether usually, and wood alcohol and some other liquids occasionally, enter the body in a vaporous or gaseous form. Gases may produce death in any one of several ways: by acting mechanically to exclude oxygen, and so cause suffocation, as in the case of nitrogen; by forming combinations with the blood to prevent its taking up oxygen, even if it has the opportunity, as in the case of charcoal gas; by causing paralysis, or change of nerve-tissue, as in the case of chloroform or wood alcohol; by causing such irri-

tation of the glottis as to close it by swelling, and so induce suffocation, as does ammonia; by directly irritating and burning the parts it touches, as do phosgene, chlorine, and especially mustard gas, which burns the skin as well as the respiratory tract.

Liquid poisons may also cause injury or death in a great variety of ways. The group includes a large number of substances. Some of them, such as *sulphuric* and *nitric acid,* do injury by their strong corrosive properties; others, as alcohol, act on the nerves. They usually enter the body by way of the mouth, but, as in the case of the acids, they may act on the surface, or enter through wounds.

The poisons occurring in *solid* form are even more numerous than the others, and they enter the body in the greatest diversity of ways, and produce manifold symptoms. *General poisons* include a great variety of substances, such as arsenic, phosphorus, antimony, mercury, lead, and a great many more. They may be taken knowingly with good or evil intent, or in ways not known at the time, and often difficult to trace. The amount taken at one time may be almost infinitely small, yet its frequent repetition may result in poisoning. Thus, a painter may contract lead-poisoning from the minute amounts of lead getting on his food from unwashed hands, a beer-drinker from the lead taken into solution from lead pipes through which the beer is drawn.

Alkalies, such as *caustic potash, caustic soda, lye,* and *quicklime* are powerful irritants or caustics.

Vegetable poisons include substances producing disease or death in a great variety of ways. Some of the most common and familiar of these are *opium, strych-*

nine, *cocaine*, and *jimpson weed*. Most of the enslaving drugs — alcohol, opium, cocaine, and others — are of vegetable origin. Habitual users of them may get to using enormous doses, some of them several times the amount that would be fatal to persons not so habituated. Some vegetable poisons are very irritating to the skin and cause marked eruptions. Croton oil causes pustules that resemble those of smallpox. Poison ivy owes its evil qualities to an oil that occurs in and on the leaves and that causes the well-known inflammation of the skin.

Many of the chemical poisons are the products of germ action. Alcohol, the best known, results from the action of yeast cells on sugar. *Ptomaines* result from the action of germs on meats, fish, milk, and other foodstuffs. There are a great many of them, and their effects vary greatly. Some of them resemble drugs, such as morphine, strychnine, or atropine, in their action, and, as their presence may not be suspected at the time they are taken into the system, the symptoms produced by them may prove very puzzling. It should be borne in mind that ptomaines may not be destroyed by boiling, and cooking should therefore not be depended upon to render partially decomposed meat safe. Many of them are harmless, but neither can that fact be depended upon to show that a given article of food is wholesome. Their poisonous character depends on the type of organism producing them, rather than on the stage of decomposition. Thus one piece of meat may be quite rotten, and yet not poisonous, while another that is free from odor and presents a fairly good appearance may be very dangerous.

The foods that most often give rise to *ptomaine poi-*

soning are those that have been preserved imperfectly, such as beef or fish in cans that have become perforated or blown, cold-storage beef that is not well frozen or chilled, poultry imperfectly chilled, especially if it be undrawn, and imperfectly cured hams and sausages. The symptoms vary considerably, depending on the source, character, and amount of the poison ingested, but in most instances they include evidence of marked gastro-intestinal and nervous disturbances, such as vomiting, diarrhœa, headache, dizziness, and cramps. One of the most insidious and deadly varieties of food-poisoning, that known as *botulism*, has lately become well known in this country, mainly because of numerous deaths resulting from the use of contaminated, bottled olives. This poisoning is due to a toxin elaborated by *Bacillus botulinus*, a spore-bearing organism known for many years, and formerly better known as the cause of sausage poisoning. It may contaminate canned meats or vegetables, but it usually so alters their odor and taste as to make them disagreeable. Careful avoidance of canned goods which have a spoiled odor, appearance, or taste will usually protect from it, and, as boiling temperature destroys the poison elaborated by this bacillus, the re-cooking of canned goods before use will make them safe. The term *ptomaine poisoning* has attained such general and careless use that it is commonly employed in reference to almost any acute sickness or poisoning following or resulting from the use of foods, a meaning very different from that originally given it. *Self-poisoning* or *auto-intoxication* may be due to ptomaines or other decomposition products resulting from the putrefaction of food, occurring in the stomach or bowels, or to simple re-

tention and absorption of poisonous products which would ordinarily be eliminated, but which, because of constipation, kidney disease, or for some similar reason, remain in the body. Such poisonings are promoted by overeating, lack of exercise, and by excessive drinking or smoking, as well as by diseases.

Disorders of internal secretions. Certain small organs of the body, known as the ductless glands or glands of internal secretion, have a tremendous influence on development and welfare, and their injury or destruction may cause grave disease. Among such disturbances are exophthalmic goitre, due to excess of secretion of the thyroid gland, and myxœdema and cretinism, the latter a form of idiocy, due to its absence. Simple goitre, or enlargement of the thyroid gland, is usually due to lack of iodine in the system and may be prevented by the supply of small amounts of this element. The most familiar instances of the influence of internal secretion are seen in the absence of the usual sex characters in animals castrated or spayed when young, the absence of testicular or ovarian internal secretion being responsible. The differences shown in the development of a stallion and that of a gelding, of a bull and a steer, a ram and a wether, a normal bitch and a spayed one, are obvious to all.

Animal poisons, in addition to the products of animal waste to which reference has just been made, include such substances as *snake-venoms* and those of stinging insects and spiders. These vary greatly in their composition, and their effects range from the slight itching and burning of a mosquito bite to the agonizing deaths following some snake bites. The venoms are introduced through wounds, many of them

being harmless if applied to the unbroken skin or even if taken by mouth.

Deprivation diseases have been discussed in the chapter on foods.

Large animal parasites. The most important group of the larger animal parasites that infest man is that of the intestinal worms. Their distribution is world-wide, and in some places they are so prevalent and their effects so serious, that they exercise very important influences on the morbidity and mortality rates. They may be grouped in three classes: the flukes or sucking-worms, the tape-worms, and the roundworms.

Flukes[1] or *sucking-worms* are not common parasites of man in our own country, but in some parts of the world they are very prevalent and cause serious illness. Several varieties occur in the Philippine Islands, and some of them cause death. One variety occurs in the lungs, and causes blood-spitting and cough that may lead to the belief that tuberculosis is present; or it may lodge in the brain and cause paralysis or other cerebral symptoms. Other varieties live in the veins of the liver and may produce disease of that organ, while their sharp-pointed eggs lodge in or perforate blood-vessels of the bowels or bladder and cause bleeding, irritation, and other symptoms. This is a type of the *schistosomum* disease mentioned in the preceding chapter. These flukes gain access to the body from water bathed or waded in, after first reaching an advanced stage of development in the livers of certain snails, from which they then escape into the water. They pass through the skin of persons using the water. The Japanese

[1] Flukes in general, so far as their life-history is understood, have at different times four forms or stages and two or three methods of multiplication.

schistosomum undergoes its earlier stage of development in the body of a fresh-water crab. The obvious means of prevention are, first, to prevent infected or egg-bearing feces or urine from reaching water; second, to boil or otherwise sterilize the drinking-water; third, to abstain from bathing in infected water unless it also be boiled or filtered; fourth, to avoid the use of uncooked foods that may have been contaminated by bad water.

The *tapeworms* are better and more widely known as human parasites. There are many varieties of them, but the best known are those large species ingested with beef and pork, though others are important, and some of these, such as the broad tapeworm from fish, may be very important in places. The life-history of tapeworms, while not so complicated as that of flukes, involves, in most instances, residence in two animals, and knowledge of it enables us to understand the manner in which infestation occurs, and the method of avoiding it. Life begins in the eggs, which are passed from the worm into the bowel-contents of its host, and thence to the outer world. Here they may fall into water or on vegetation, or the excrement itself may be ingested by animals. At any rate, the eggs must, in one way or another, get admission to the alimentary canal of the second host, for which purpose a particular species of animal is necessary. In the case of the beef tapeworm, this host is the ox, in that of the pork tapeworm, the pig. Rarely this development may occur in other animals, or in man himself, but ordinarily development will not occur in any but the usual host. Having reached the stomach of this host, the embryo is set free when its enveloping shell is dissolved, and penetrates the wall of the stomach, whence it passes by the blood vessels to

the liver, muscles, brain, or other part of the body, where, after undergoing some further development, it becomes the head and neck of a future worm, inclosed in a small bladder-like cryst or measle, from one fourth to three fourths of an inch in length and about one third of an inch in diameter in the case of the pork measle, and somewhat smaller in the case of the beef measle. If now the flesh of the infected pig or ox be eaten raw, or not cooked sufficiently to kill the worm, it may pass unharmed to the bowel of man and there attach itself and grow. The head and neck as ingested are very small, bearing comparison in size to a small pinhead and a piece of fine twine. From this head and neck the rest of the worm develops in the bowel. The part so developing consists of a great number of segments, at times hundreds, each flat and white, so joined together as to form a long flat ribbon that may attain a length of thirty or more feet, each segment having a nervous and alimentary system and male and female generative organs, and each developing, fertilizing, and discharging eggs, so that each tapeworm, though an individual, may be said to be also a community. It may be readily understood from the above that allowing pigs to act as scavengers of human ordure, as is often the case in the tropics, is not a wise sanitary measure. It was stated above that man might rarely be the measly host. In such cases he might become infected with eggs by means of contaminated water, or of lettuce or other green vegetables manured with human feces, by getting the minute eggs on his hands in water-closets or from his own stool, or by having them pass from the bowel to the stomach during vomiting. Several other varieties of tapeworms may infect man, — one of the most dangerous, and one for

which man may shelter the cystic stage with fatal results, being derived from the dog, and another dangerous one possibly being derived from the rat, which may deposite the eggs on food articles with its feces.

Many varieties of *roundworms* infest man, and their life-histories vary greatly. A few varieties will be briefly discussed in order to indicate more clearly the necessity of certain sanitary precautions. Those most commonly inhabiting the human intestine — *the large, white roundworm*, the *whipworm*, and the *pinworm* or *seat-worm* — require no other host, and infection occurs, directly or indirectly, from man to man. The eggs are laid in the feces and pass from the anus, whence they may get on the hands, into drinking water, or on green vegetables, and so obtain entrance to the mouth and stomach of the same or another person. The embryos are set free in the stomach or intestine and develop into adults. Probably the most common method of infection is by means of polluted water. Children and adults who are infested with seat-worms may reinfect themselves many times, by reason of the fact that these worms often crawl from the anus and give rise to most intense itching, in the efforts to relieve which the hands and nails pick up many of the microscopic eggs, which may later be transferred to the nose or mouth.

The *hookworms* are probably the most important of all the worms infesting man, both because they may and do infect the great majority of the inhabitants in some tropical countries, and because they so seriously reduce health and strength. In Porto Rico, the Philippines, and our own Southern States, infestation with these worms is common, and thousands and thousands of persons are debilitated or incapacitated, and have

their resistance to other disease reduced by it, with the result that industrial progress is delayed and physical degeneracy and high sickness and death-rates promoted. Formerly it was believed that infestation with this parasite occurred in the same manner as with those just described, but it is now generally admitted that it usually, if not always, occurs in another way. The usual history is about as follows: The adult female produces a great number of eggs that pass out from the host with his feces. If passed on moist, warm earth, the eggs hatch and liberate microscopic embryonic worms which eat feces or other organic matter, live and grow in the moist earth, and eventually, if fortunate, find an opportunity to get on the bare feet or other skin-surface of a person, penetrate the hair follicles and the true skin, producing itching and irritation, and causing "ground itch," gain access to the lymph or blood-vessels, and are carried, by way of these channels, to the lungs. Here they leave the blood and pass out on the mucous membrane, crawl up the windpipe to the throat, from there down to the stomach, and then to the small intestine, where they take up their abode, reach adult life and a length of one third or one half an inch, and in turn produce eggs to infect more polluted soil. In addition to this, they produce a very serious anæmia or thinning of the blood, which gives rise to weakness, shortness of breath, dropsy, mental dullness, and, in children, checked development and stunted physique and mentality. Such conditions impair the body's resisting powers, and the victims more readily succumb to malaria, dysentery, and other diseases.

The short outline of the life-history of the worm just

given indicates the wisdom of the following measures to prevent the spread of the infestation; first, treatment of all infested; second, proper disposal of feces to prevent soil-pollution; third, the wearing of shoes in infected regions; fourth, the use of pure drinking-water.

Trichiniasis is a disease produced by infestation with a kind of roundworms, *trichinæ*, that presents still another life-history and method of infestation. The trichinæ are small worms about a sixteenth of an inch in length that are natural parasites of the rat, but may also infest man and many other animals, including the pig and dog. The danger to man lies principally in the fact that the pig is a rather common host, and it is from that source that he derives his infection. The history is as follows: Rats become infested by eating their infested kindred, and they in turn may be eaten by pigs. The larval worms are encysted in the muscles, as will be described later, and are set free in the pig's stomach, when the muscle and cyst are digested. They then pass to the bowel, where they take up their abode, mature, and bore into or through the intestinal wall to the lymph spaces, where they deposit their numerous progeny, averaging about fifteen hundred in number. These are carried along by lymph or blood-streams, or possibly by their own activity, to various parts of the body, finally penetrating the muscle fibres and setting up an irritation that results in the formation of little capsules about them. Here they live quiescent, but capable of development, for an indefinite time, occasionally for years. Too often, however, this rest is shortened by the death of the pig and its later consumption by man. If such consumption is preceded

by thorough cooking no harm will result, as the heat will destroy the worms; but if, as is sometimes the case, the meat be eaten raw or underdone, the larvæ are set free in the man's stomach as the others were in the pig's, and he in turn develops adults, has larvæ scattered through his muscular system, and suffers from pain, fever, symptoms resembling typhoid, and, possibly death.

Filaria, a roundworm whose larvæ circulate in the blood, presents a still different history and method of entrance to the body. For at least two varieties, whose development has been pretty well traced, the history is as follows: The young or embryonic forms are imbibed with blood by mosquitoes that bite infected persons. In the blood these embryos, which are about one eightieth of an inch in length, are enclosed in loose individual sheaths or capsules, within which they wriggle about very actively. After reaching the mosquito's stomach the blood containing them clots and they break through their sheaths, and, after about a day, through the stomach-wall. They live in the body of the mosquito, growing and maturing, for two weeks or more, at the end of which time they have increased to four or more times their original length, and have gathered in or about the fleshy part of the mosquito's proboscis. When the mosquito next bites a man they break through a thin part of the proboscis and pass through his skin by the small wound from which the mosquito is extracting blood. Once in the body, they wander in ways and parts unknown for an indefinite time, until they reach maturity, and, if both sexes be represented, begin to turn out embryos for other mosquitoes to ingest. The adults are very apt to take up their abode in lymph-

vessels, and by their residence there they set up irritation that leads to blocking or obliteration of the channels and is thought to be the cause of lymph-scrotum, chyluria (milky urine), elephantiasis, and kindred troubles. Certain *insect larvæ* that bear a resemblance to roundworms occasionally infest man. Blow-flies may deposit their eggs on meat that is left carelessly exposed, and, if they are not destroyed by heat, maggots may hatch from them and appear in the stools of persons eating it. Flies also deposit eggs, and maggots develop, on neglected sores, wounds, or ulcers, which may later be burrowed in many directions.

Screw-worms are the maggots of a small fly found in some of our Southwestern States, in Central America, the Isthmus of Panama, and elsewhere. This fly deposits its eggs in the nostrils, or occasionally, on other parts of sleeping persons, especially those afflicted with nasal disease or very foul breath. The maggots hatch out in a few hours and bore their way in all directions, causing great suffering and, in many cases, death. Among twenty-three cases reported from Arizona in the fly season of 1905, there were four deaths.

Some flies deposit their eggs on or in the skin of animals, and the larvæ develop there, constituting "warbles" in cattle, deer, and wild rabbits. Occasionally man is host, though this is rarely so.

Some insects burrow into or beneath the skin in their adult condition, and there nourish themselves and sometimes deposit their eggs or their young. They cause irritation or disease. Among them may be mentioned the *itch-mite*, *jiggers* or *chiggers*, and many kinds of *ticks*. *Itch* was at one time a very widespread, common, and intractable disease, but before the World

War it had almost disappeared from the army. During that war it again assumed large proportions in the allied armies, and it is an interesting fact that in a large majority of cases it was conveyed by sexual contact and was sometimes classed with the venereal diseases for that reason.

Lice of various kinds had also almost disappeared from the peace-time army, but like itch they spread very extensively among many units in the A.E.F., and the delousing of returning troops was a large problem at embarkation centres.

Leeches are at times a great pest and cause much loss of blood, particularly in some parts of the Philippines, where they get on troops marching through the jungle, in great numbers. They may get on the body from water or from vegetation. Clothing is the main source of protection from them.

Minute animal parasites. A number of very important and well-known diseases are caused by animal parasites of such extremely small size and so low in the scale of animal life that they may, for our purposes, be regarded as closely allied to the bacteria. In fact, even scientists are not agreed as to whether some of them — for instance the germs of syphilis, yaws, and relapsing fever — are animal or vegetable. A brief consideration of some of the small animal parasites and the diseases they cause may be helpful.

Malaria is the best known and most common of such diseases, and the parasites causing it are better known than most of the others occurring in man. There are at least three varieties of malaria, each caused by its peculiar type of organism, though these types have much in common. They all live in the blood and

in its red corpuscles, when so small as to be almost invisible with the microscope, and there grow to a considerable size, destroying the blood-cell and converting it into a mere shell and some pigment granules. In twenty-four, forty-eight, or seventy-two hours, depending on the variety of organism, they segment or break up into a number of small new organisms, the number varying from six or eight to fifteen or twenty, and also depending on the type. These young forms are set free in the blood-stream with the breaking up of the shell of the blood-corpuscle in which they were contained, and in turn attach themselves to new red cells, to repeat the performance. Corresponding to the liberation of the swarms of young comes the "ague fit," or the malarial chill, fever, and sweat, and it depends upon the type of organism whether this comes daily, once in two days, or once in three. Various combinations of infections may make the chills appear to come very irregularly, but such irregularities are often explainable if the case be well studied. After a time the body develops powers of resistance that enable it to overcome the effects of the organism, and spontaneous recovery may occur. Or the recovery may be apparent only, and the disease may recur when chill, exposure, or other illness lowers vitality. Malaria causes many deaths, especially in the tropics, in India about one million annually; but if a single infection is not fatal very soon, the tendency is to recovery, as the parasites cannot maintain their powers indefinitely unless they renew their strength (in some unknown way) by *sexual reproduction*, and that can only occur in *mosquitoes* of certain kinds. Minute differences can be detected among the parasites of any kind of infection, and these are now known

to mark sexual differentiation. If the right kind of mosquito bites the infected individual, these sexual differences become more marked in its stomach, and sexual conjugation there takes place. The impregnated female (this term is not accurate, but it conveys the idea) bores into the stomach-wall and undergoes a development which eventually results in the production of hundreds or thousands of young forms that finally find their way to the salivary glands and mouth of the mosquito, and enter, by way of the wound made by the insect, the next man it bites, and the cycle begins again in him. All malarial infections are conveyed in this way, and where there are not the right kinds of mosquitoes the disease cannot originate. So far as known, man is the only animal, and mosquitoes of the genus *Anopheles* the only insects, that respectively harbor and transmit malaria, and each derives its infection from the other. Each should therefore be kept away from the other.

Amœbic dysentery, so well known to our army because of the great amount of invalidism it has produced among our soldiers in tropical service, is also due to an animal parasite of microscopic size. This is a minute round mass of living substance endowed with the capacity for motion, by virtue of which it inserts itself between the body cells or wraps itself about them and digests them; destroying tissue and giving off poison, it causes the formation of ulcers in the bowel, inflammation of the intestinal surface, bleeding, wasting, diarrhœa, and, too often, death. Entering the blood or lymph-streams through the ulcers they make in the bowel, the amebas may reach the liver and here set up the dreaded disease known as liver abscess. The amebas

enter the body in polluted water, and possibly also on lettuce, radishes, and other vegetables that are eaten uncooked.

Sleeping sickness, a disease unknown in our possessions but caused by a parasite closely related to that causing the well-known and fatal *surra* of horses in the Philippines, is widespread in central Africa, and has caused tremendous loss of life there. The organism and disease are transmitted by the bites of tsetse flies.

Syphilis, known everywhere, is caused by an extremely fine organism of spiral figure. This is about 1-2000 of an inch in length, and the thread that is twisted into the spiral shape, the organism itself, is about 1-100,000 of an inch thick. This extreme fineness, and the difficulty with which the germ stains, account for the fact that it remained so long undiscovered. This organism, which is called a *Treponema*, is not known to occur elsewhere than in syphilitic subjects, but it occurs abundantly in lesions of the disease and is free on the surface of such moist sores as the open chancre and patches in the mouth. If from these it passes to wounds, cracks, or other open and moist surfaces on a healthy person, as may occur in kissing, sexual congress, or other contact, the disease is transmitted.

Yaws, a skin disease that occurs in the tropics, is caused by an organism indistinguishable in appearance from that of syphilis.

Many other diseases are produced by animal parasites, but it is unnecessary to consider them here.

Certain diseases, such as *yellow fever*, *dengue*, and *trench fever*, are produced by unknown organisms that pass through fine filters and are probably so small as to

be invisible to our microscopes; yet the course and history of the diseases point to an animal rather than a vegetable cause.

Vegetable parasites. The disease-producing vegetable parasites are of three classes, *moulds*, *yeasts*, and *bacteria*, all microscopic in size and all of them germs. The moulds and yeasts are of minor consequence as compared with the bacteria, and cause relatively few diseases, and those principally of the skin. Fatal general infections by germs from both of these classes have, however, been reported. Persons who have served in the tropics recall how difficult it is there to keep shoes, clothing, trunks, and many other articles from moulding or mildewing, especially during the rainy season. Heat and moisture afford such excellent conditions for growth that a pair of shoes will turn green in a very short time. As related vegetable forms are responsible for many of the most common skin-diseases of the tropics, the fact helps us to understand the prevalence of the latter. Not all moulds are harmful, and most of them are mere surface growths. The mistake is occasionally made of rejecting a quite good ham, for instance, because it is mouldy on the outside. Such mould can be trimmed off with the rind, and does not injure the meat. Roquefort and some other cheeses are dependent on moulds for their flavor, and are not good if these be absent.

Bacteria, however, are the best known of the causes of disease, so well known as such, in fact, that two erroneous ideas have arisen in consequence: one, that all bacteria produce disease, the other that all disease-producing germs or micro-organisms are bacteria, or, to touch a still greater error, bacilli. Bacteria are micro-

scopic, one-celled organisms of vegetable nature that multiply by simple fission. So far are they from being universally harmful, that life would soon disappear from the face of the earth if all bacteria were killed. This is because of the fundamental difference that exists between bacteria and the larger forms of vegetation. All animal life is maintained directly or indirectly by vegetable life, even the lion and tiger being dependent on the herbivorous deer and similar animals. Most vegetable life draws its substance from the elements and simple compounds of the earth, air, and water. In other words, grass or a tree cannot eat dead grass, meat, or other highly organized substances, until they are first decomposed and broken up into the elements and simple compounds indicated, and returned in those forms to the earth, air, or water. For this purpose bacteria are necessary, and without their action the earth would soon be covered with dead animals and vegetables, the fertility of the soil would be exhausted, and life would be choked out by the accumulation of its products. Because of this difference and the fact that bacteria do not contain cellulose, as do ordinary plants, it has been proposed to class them as a separate kingdom and regard them as neither animal nor vegetable.[1]

Bacteria are found practically everywhere in nature, and many trades and industries are dependent on their presence. They are classified according to shape, grouping, action, and other qualities. Thus some are called putrefactive, others nitrifying, and others pathogenic or

[1] "It has been generally assumed that bacteria are low forms of plant life, but researches . . . show that bacteria contain no cellulose and are particulate, unshielded proteins and consequently are more nearly related to low forms of animal life. I should not classify bacteria as either plants or animals." — V. C. VAUGHAN.

disease-producing. The more common forms are designated as *cocci*, or little balls, *bacilli*, or little rods, and *spirilli* or *vibrios*, or little spirals or pieces of spirals. Cocci in pairs are called *diplococci;* bound together in chains, *streptococci;* gathered into bunches like grapes, *staphylococci;* and, as each organism tends to grow always in the same way, such names become permanently attached as more or less generic. Thus we speak of the streptococcus of erysipelas, the diplococcus of pneumonia, and the yellow staphylococcus of suppuration.

Bacteria may also be *aërobic* or *anaërobic;* the former unable to grow without oxygen, the latter with it. *Tetanus* or *lockjaw* is caused by an anaërobic bacillus, and that probably partly accounts for the fact that it is most apt to follow small deep wounds, such as nail-punctures, to which the air does not have free access.

Reproduction among bacteria is by fission or simple division. One bacillus divides crosswise into two, the two into four, and so on; and so rapidly does the process advance, that under favorable circumstances the increase amounts to uncountable millions or billions in a day. The rapidly multiplying individuals may be bound together in gelatinous masses that are of considerable size, at times forming a skin-like layer many yards in extent. When conditions are less favorable, as when all the food-supply is exhausted, the temperature too high, or harmful chemical substances present, the bacteria usually die; but some varieties may preserve themselves under such circumstances by the formation of *spores*. These may be compared to the seeds of larger plants in that they are much more resistant to heat, cold, and other harmful influences, and, after surviving such trials, may again give rise to growth. An-

thrax bacilli, for instance, are readily destroyed by heat, but their spores will withstand boiling for some time. In preparing media for the cultivation of bacteria it is therefore the practice to sterilize them at a temperature higher than that of boiling water, or to use that temperature on three successive days. In the latter event the bacteria develop from the spores after the first sterilization and are killed in their less resistant forms. The amount of heat required to destroy bacteria, what is called the thermal death-point, varies greatly with the species. Some organisms found in water, none of which, fortunately, produce disease, flourish in a high temperature. All disease-producing organisms, except those in spore form, are promptly destroyed by boiling, and many of them by a lower temperature. Few ordinary organisms will survive a temperature of 57° C. for more than a short time, and this fact gives the process of *pasteurization*, as applied to milk, its value. This is the process whereby milk is heated to a point between 65° and 70° C. and maintained at that temperature for ten or fifteen minutes. This kills the disease-producing organisms, without changing the taste and character of the fluid as does boiling. For the same reason, satisfactory results have been obtained in the British service with a camp water-heater that raises the supply to 85° C. for only a very short time.

Moisture is necessary for the growth of bacteria, and drying checks their growth even when it does not kill them, as it does many varieties. Being solid bodies heavier than air, bacteria are not given off from moist surfaces. Occasionally they may be thrown into the air with droplets of water by the bursting of bubbles, but in general a tubfull of bacteria-laden water would not

endanger the purity of the atmosphere. On the other hand, dried or partially dried bacteria may be blown about as dust and do much harm. Cuspidors and water-closets should therefore always contain water. *Sunlight* is a great enemy to most pathogenic bacteria, some of them, for example the cholera germ, being killed by a very brief exposure to it, and all being injured by it. Many chemicals, such as bichloride of mercury and carbolic acid, kill bacteria *when brought into contact with them.* Such mistakes are often made as that of regarding a stool disinfected because some antiseptic solution has been poured over it. As a matter of fact, the antiseptic in such a case is only brought in contact with the surface of the fecal mass and the great bulk of it is quite as dangerous as before.

One variety of bacteria may tend to destroy another. Thus typhoid bacilli will keep alive much longer in sterilized than in contaminated water, the common water-organisms in the last case crowding them out; and fecal matter and its contained bacteria are very quickly made to disappear if mixed with dry earth containing an abundance of nitrifying bacteria, while, if mixed with ashes, which are sterile because burned, they persist much longer. This warfare of bacteria has had exploitation because of the interest attaching to the recommendation that certain milk-souring bacteria be ingested for the purpose of crowding out from the intestines more harmful varieties, and so lessening the danger of poisoning by the products of these. This explains the occasional excellent effects of the use of buttermilk as a diet.

On the other hand, one variety of bacteria may increase the danger or power of another variety. Thus

the tetanus bacillus, being anaërobic, cannot grow in the presence of oxygen; but if introduced into the body with a variety of organism that uses a great deal of oxygen, the latter may soon bring about practically anaërobic conditions in which the former can flourish.

The virulence of the streptococcus of erysipelas is greatly increased if the organism be grown with *bacillus prodigiosus*, an organism that is itself not pathogenic. Smallpox, though more than a simple suppuration, is always associated with that process and with the common pus-producing bacteria.

Some bacteria produce disease by means of the poisons or *toxins* that they set free, rather than by their physical presence in the tissues. The bacilli causing diphtheria and those causing tetanus, to cite examples, produce soluble toxins which can be obtained in germ-free solutions and which, when injected, produce the symptoms of the diseases, even though none of the actual germs are introduced.

Other bacteria, such as those of plague, typhoid, cholera, and tuberculosis, do not produce soluble toxin, unless it be that one is set free when the bodies of the bacteria are digested or disintegrated. Such bacteria are at times spoken of as forming *endotoxins*. The exact manner in which they cause disease is not thoroughly understood, though recent investigations indicate that there are two main factors involved: (1) The bacteria, in their efforts to nourish themselves, digest and so destroy certain body cells. (2) The body cells, in their efforts to defend themselves from injury, destroy the bacteria by digesting or breaking them down, and by so doing liberate from them certain products that act as chemical poisons. The greater and more rapid

the defensive digestion, so is greater and more rapid the liberation of the harmful products, and the more acute and violent are the symptoms of disease until, by practice, the cells learn to digest also the freed poisonous products, when recovery may occur and immunity be established. In other words, the manifestations of disease may be quite as much evidences of the body's resistance to infection as of the existence of infection.

Anaphylaxis. Similar digestion by the body cells, rather than by the alimentary tract, of protein other than that contained in bacteria, such proteins, for example, as egg- or serum-albumen, is thought to account for " serum sickness " and other manifestations of anaphylaxis.

It is easier to give examples of anaphylaxis than to explain it. If a dog or a guinea pig be injected with a dose of horse-serum it suffers no apparent harm, but if, after an interval of three weeks or more, it be injected with another dose severe symptoms appear promptly and death may ensue within a few minutes or a few hours. The animal became " sensitized " to horse-serum by the first dose.

Human beings become sensitized to various foreign proteins and suffer from various symptoms in consequence. The inhalation of ragweed pollen causes hay fever in sensitized persons. The mere odor of a horse may serve to bring on an attack of asthma in an individual sensitized to horse-protein, and one such individual died in 1919 as the result of an injection of *one drop* of horse-serum, although medical men and facilities were at hand and every known measure of aid was promptly applied.

CHAPTER X

DISEASE-CARRIERS

IT has been stated in preceding chapters that diseases are oftentimes diffused by persons, animals, insects, or inanimate substances that act as carriers of the infective matter or germs. It will greatly aid in the maintenance of the health of troops if company officers and the men themselves have a proper realization of such methods of spreading disease, and the better-known and more important groups of carriers will therefore be considered.

Human carriers. Man himself is the most important carrier of his own diseases, and most epidemics arise from the presence of one case of disease in man. Isolation and quarantine are designed to limit or prevent disease-transmission in this way, and in the case of measles, scarlet fever, smallpox, and similar diseases the danger is recognized by all. It is not so generally recognized in many other common and serious diseases, such as typhoid and colds, although the tremendous epidemics of respiratory diseases in mobilization camps and in civil communities in 1917, 1918, and 1919 did much to popularize the lesson. Measles, influenza, and pneumonia did such havoc that most persons suffering from colds became justly suspect. It is not the purpose, however, to discuss here the danger arising from contact with well-marked cases of disease, but rather to consider the unknown or unrecognized carrier. Several diseases may be widely disseminated by persons en-

tirely ignorant of the fact that they are sources of danger. This fact has long been recognized in regard to some infections, is just receiving recognition in regard to some others, and is possibly not recognized at all in regard to still others. For several years it has been a matter of scientific demonstration that active and virulent *diphtheria* bacilli may linger for weeks or months, in the mouths, throats, or noses of persons who have recovered from the disease and who appear quite healthy. It has also been demonstrated beyond dispute that some mild sore throats, " colds," and nasal discharges are due to diphtheria germs, even though the subjects do not feel particularly sick and the diseased parts do not present the appearance formerly considered characteristic of diphtheria. Other persons who have no sore throat or other evidence of disease, but who have been in contact with cases, as nurses or otherwise, may harbor the germs. Persons in any of these classes may ignorantly and innocently introduce the disease in new localities, transmit the germs to susceptible people, and so start epidemics. One such person in a crowded and ill-ventilated squad-room in winter may endanger the whole command, and if, in addition, he is a person addicted to careless spitting, to the use of other men's pipes, cups, or linen, the danger is greatly increased. The wise and necessary precaution in military life is to examine and reëxamine all men who have had or been exposed to diphtheria, and to keep them isolated until it has been repeatedly demonstrated that they are free from germs, and to isolate cases of sore throat as though they were all diphtheritic.

That influenza is widely spread by persons who do not realize that they are real sources of danger is well

demonstrated, and it is probable that one of the most important reasons for our failure to control epidemics of this disease is that a large proportion of the public has been exposed to it before the danger is appreciated.

The germs of *cerebro-spinal meningitis* and *infantile paralysis* are also occasionally found in healthy mouths and noses, and the diseases may be transmitted by such healthy carriers. Scarlet fever often leaves an irritated throat, a nasal discharge, or a running ear, and persons who have otherwise recovered from it may transmit the infection to others and so start epidemics.

Typhoid carriers constitute one of the means of *typhoid* transmission that is now best recognized and is always considered in the investigation of an outbreak of the disease. A chronic typhoid carrier is usually a person who has had the disease and apparently recovered, but who continues to excrete typhoid bacilli in his feces or urine. Occasionally, however, a carrier is found who gives no history of the disease. Then, too, persons in the early stages of the disease may act as carriers and cause wide dissemination of the infection before they give up to their sickness.

The germs of *cholera* and *dysentery* may be passed by persons quite ignorant that they harbor them, and may give rise to infection through contact, water, the use of latrines from which flies may obtain the germs, and in other ways. Epidemics of bacillary dysentery or "flux" not rarely result from carelessness on the part of a carrier or a man but slightly sick. During a jail epidemic of cholera which was started by a carrier at Puri jail, in India, in 1912, thirty convalescents were examined at the time of their discharge from hospital and eleven of them found to be still excreting cholera

germs. In August, 1911, six cases of cholera were admitted to the quarantine hospital at Ellis Island, fifteen cases developed in quarantine, and thirty-one carriers were detected.

As stated in the preceding chapter, man is the carrier of the commonest *intestinal worms*, and it is his ignorance or carelessness that is responsible for their spread. Persons who spread *tuberculosis*, *tonsillitis*, and other troubles by their careless spitting usually do it in ignorance of the fact that they are doing wrong. Most consumptives do not realize that they have the disease until after they have been expectorating tubercle bacilli for some time. Other disease-carriers who may be quite ignorant of the rôle they are playing are sufferers from certain eye and skin diseases, such as *trachoma* or granular lids, *gonorrhœal inflammation of the eyes*, *ringworm*, *itch*, *impetigo*, and many other diseases of the skin. They may either be ignorant that they have any disease, or that the diseases they have are contagious, and so, by careless contact, the use of public towels or brushes, or those belonging to other persons, through barbers' chairs and in other ways, they may infect many persons.

Nurses and doctors may at times carry and transmit infectious diseases, such as *measles*, *smallpox* or *typhoid*, either innocently, as when a diagnosis cannot yet be made and they do not know of the dangerous contact, or culpably, as when they know of the danger but do not take proper precautions to guard against it. *Venereal diseases*, both gonorrhœa and syphilis, may be innocently transmitted, quite aside from any question of sexual intercourse. A syphilitic infant may infect its nurse; a girl may get a chancre of the lip from kissing a person who has infective lesions in the mouth

and does not know it; or possibly, though it must happen very rarely, by following a syphilitic in the use of a communion cup or other public drinking-vessel; doctors occasionally become infected with syphilis through needle-pricks or slight scratches that become infected during operations. A child may contract gonorrhœa from sleeping with or against its infected mother, or an infant's eyes may be infected during its birth, and others may become infected through handling it. Many men who thought themselves quite free from all venereal disease have infected their innocent wives through sexual intercourse, and every man who has ever had venereal disease should seek the examination and opinion of a competent physician before entering the married state.

The company officer cannot be expected to recognize the various disease-carriers in his company, but he can aid in their detection if he sees that all sick men report promptly to the surgeon, and that they remain on sick report until no longer sources of danger. Occasionally a company officer takes the unreasonable view that a man who is able to do a bit of window-washing or other light work about the hospital should be sent to his company. Such action might result most seriously both to the company and the man and the wise company commander will very rarely, if ever, clamor for a sick man. Even diseases not directly transmissible, such as malaria, constitute a menace in barracks, and the victims are, ordinarily, not only better off, but also less dangerous when in hospital. A man infested with worms may be capable of working and may desire to do duty, but he cannot be so well treated elsewhere as in hospital, nor will the disposal of his stools be so well looked after if he be free to go and to defecate where he pleases.

Animal carriers. Certain diseases are derived exclusively or almost so from animals. Among them are many very dangerous infections, some of them quite incurable. We will consider some of these.

Hydrophobia is a disease that affects a great many kinds of animals and is almost uniformly fatal. It is ordinarily considered a disease of the dog family, but there is some reason to believe that it is naturally a disease of certain herbivora, especially rabbits, and the dog contracts it from these. So far as man is concerned, however, it may be considered as originating with the biting animals, especially the *dog, wolf, fox, cat,* and *skunk.* By these it may be transmitted to horses, cattle, and other domestic animals, and to man himself. No cure is known for the disease after it has actually begun, but if treatment be begun soon after infection, immunity may be established before the incubation period has ended, and the onset thus prevented. As there are three prevalent errors regarding this disease, each fraught with the possibility of serious consequences, they will be briefly discussed here.

The first of them is the somewhat widespread belief that the disease does not exist, that its victims really die from fright. This is abundantly disproved by the deaths of people who were not frightened, who for weeks or months had forgotten the incident of the bite; by the ability to infect and kill rabbits, dogs, and other animals, by inoculation from animals dead of rabies but not from those dying of other diseases; by the infection and death of cattle, horses, and men; by the bites of rabid animals, but of no others; and in other ways. *Hydrophobia exists.*

The second error relates to the diagnosis of the dis-

ease in the dog. Not every dog that slobbers and bites is rabid, and it is foolish and frequently a cause of great and needless worry to assume that he is and kill him. The disease usually begins in the dog with a change of disposition, shown commonly by restlessness and irritability. The animal is easily startled and crouches in fear, or it may wander away from home. The appetite may fail, or there may be difficulty in swallowing food. Drinking is apparently less interfered with, and the name hydrophobia (fear of water) is not accurately descriptive. Even later, when, because of paralysis of the throat, the animal is wholly unable to swallow, it may still lap water with avidity, though it succeeds in doing no more than wetting its mouth. Change in the bark or absence of barking is often noted. The dog may show no tendency to violence, but pass from a state of bewilderment to aimless restlessness, characterized by a tendency to wander or to chew and swallow all sorts of unusual articles such as wood, cloth, grass, or earth, to paralysis and death. Or it may snap at things about it or at the phantoms of its disordered brain, and pass into a furious stage, that of typical madness, when it bites or tears at any thing or any animal in its way. Always the disease ends in paralysis, usually first showing in the muscles concerned in swallowing, later of the hindquarters, the jaw, and the entire body, death coming in from four to seven days after the onset. The disease probably begins with the invasion of the dog's brain by the parasites, and the saliva is not always dangerous at the beginning. The diagnosis can be properly made only by observation of the whole course of the disease, or by examination of the animal's brain. Therefore, the correct course of procedure is either to *capture the dog*

and confine it so that the disease may be observed, or to *kill it and at once cut off its head and send that to a competent pathologist for examination.*

The third error relates to treatment of bitten persons. It is computed that about one sixth of the persons bitten by rabid animals develop hydrophobia, the rest escaping because the saliva was not at the time infectious, because the clothing wiped all saliva from the biting teeth, and for other reasons. Nevertheless, the sixth that do develop the disease always die, and proper preventive treatment is essential. This consists in the cleansing of the wound with heat or antiseptics, the promotion of bleeding, proper dressing, and the Pasteur treatment for the establishment of immunity. "Madstones" and charms are quite useless.

Glanders is well known as a disease of *horses* and *mules*, less so as a cause of human illness. Nevertheless, human beings do contract it, usually with fatal results. Its contagious and fatal characters are so well recognzed in the army, that its presence constitutes proper grounds for the destruction of animals, even though their usefulness is not yet greatly impaired. The persons who most often contract it are those concerned in the care and treatment of horses. As the disease in its early stages may not present characteristic or well-marked symptoms, it may be mistaken for a "cold," quinsy, or other less dangerous malady, and the animal be handled or treated without the observation of proper precautions to prevent infection. Special care should always be exercised to prevent any discharge from the nose or from sores on horses coming in contact with wounds, scratches, or the respiratory tract, and to keep the animal from blowing its nasal discharge or saliva

into the face of one examining it. All suspected animals should be isolated and handled as though known to be glandered until the diagnosis is settled. The disease may also be contracted from handling dead animals during their removal, or in the course of post-mortem examination, and proper precautions as to cleanliness, avoidance of wounds, and disinfection should be observed. *Glanders* and *farcy* are different forms of the same disease, are due to the same organism, and must be treated with equal respect.

Plague or *the pest* is one of the most serious and important diseases for which man owes a debt of hatred and warfare to his animal neighbors. It has not as yet gained an extensive footing in our country, but it took San Francisco and New Orleans some years to get rid of it, while the Panama Canal is menaced from Colombia, Peru, Chili, Cuba, and other points; and it is only by unremitting care that we can hope to prevent its spread there and at home. Starting in southern China a quarter of a century ago, it has since invaded each of the continents and many of the islands of the seas, while its toll has been millions of lives and vast treasure. In twenty years plague killed 10,500,000 people in India in spite of the active campaign that has been waged against it there for almost two decades.

The investigations of the British commission appointed to study the disease in India show clearly that epidemics of human plague arise after and in consequence of epizoötics of *rat plague*. The infection is transmitted from *rats* to man by *fleas*, usually those of the rat, and the relation of the epidemics to the epizoötic is beautifully shown as follows: There are two principal species of rat concerned there, the brown

or Norway rat and the black or house rat, the former also known as the ship and the sewer rat. It is among that class that the epizoötic arises, usually, and in about 7.2 days later it is also prevailing among the house rats. This 7.2 days is accounted for by the fact that it is also the average experimental time elapsing between the biting of the black rat by an infected flea and the death of the animal. (The rise of the epizoötic is measured by the numbers of rats found dead or dying.) The black rat epizoötic precedes the height of the human epidemic by from ten to fourteen days, a period accounted for as follows: The rat flea does not readily attack man until starved for three days. The incubation period of human plague is about three days. The duration of the fatal human plague averages four and a half days. Average total, eleven and a half days.

The relationship between rats and human plague is also proved in other ways, but they cannot be discussed here. The fact is established, and it constitutes the most important of the many reasons why man should be at enmity with, and try to exterminate, rats.

It must be borne in mind, however, that other animals may be infected, and wild squirrels have been shown to have the disease in California. They and gophers, prairie dogs, and similar animals may yet play an important part in disseminating it. While dirt and unsanitary conditions cannot give rise to plague, their influence in promoting the presence and increase of both fleas and rats is so well recognized that it is well to mention the matter as showing how they may strongly predispose to disease that they cannot cause directly.

The great Manchurian epidemic of pneumonic plague

in 1910 has been thought to have originated among trappers of plague-infected rodents, but, however started, that epidemic was not spread in the ordinary manner. It spread with tremendous rapidity and killed nearly all whom it infected. Transmission was by droplet infection and inhalation, the germs entered by the respiratory tract and caused pneumonia, and in the few months of its raging the disease caused thousands of deaths. However, the conditions favoring a similar spread exist in few places. During the summer myriads of Chinese go north to work in Manchuria. In winter they return, and the writer has seen train-loads of them riding all day in open coal cars, in windy weather when the temperature was below zero, and at night stopping at such places as Mukden and being packed into close and dirty inns as they were packed in the cars in daytime. It requires no vivid imagining to understand how pneumonic plague would spread like wild-fire when introduced among men so environed. So we see that even diseases that are ordinarily insect-borne may at times find man himself their most favored carrier.

In the armies on the French and Flanders fronts and also in the Italian army during the recent World War there were many cases of *acute infectious jaundice* or *Weil's disease*. This is not a new disease, but it was thought until recently to be rare. It is possible that it has been much more common than was supposed, and that most cases were considered to be other forms of jaundice, especially the common catarrhal jaundice. It is quite common in Japan, and there and in the armies it has caused epidemics. Recent work has shown that it is due to a small spirochæte and that it is common in rats. Inasmuch as this spirochæte is found in the

urine of men and animals suffering from the disease, it has been suggested that it may be transmitted by food contaminated by the urine of rats. This has not been proved, however, but we know that the disease is prone to attack persons whose work brings them in contact with rats, such as butchers, sewer-workers, miners and soldiers in rat-infested trenches. That it can be transmitted from hand to mouth or from hand to food and thence to mouth appears highly probable. The mortality of this disease varies greatly and seems to be higher where the disease is more common. It reaches 38 per cent in Japan. The incubation period of the disease induced in animals by the injection of infectious blood or urine is seven days.

Tuberculosis is the most prevalent disease affecting man, and is responsible for more deaths than any other one cause. It is also a common disease of cattle and of some other animals, and it may be transmitted to man from them. Tuberculous meat, if not sufficiently cooked to sterilize it, may be the medium of infection, but milk is probably even more commonly the carrying agent. A cow that has tuberculous disease of the udder may give off immense numbers of bacilli, and these may be ingested in a virulent condition in milk, cream, butter, or cheese. This method of infection is so common that some authorities who have devoted great study to the subject contend that it is the usual, if not the exclusive method, and they relegate infection by inhalation to a place of very minor importance. Such a view is extreme and probably not correct, as shown, for instance, by the fact that tuberculosis is very prevalent in Japan and other far eastern countries where neither milk nor beef is a common article of food. Nevertheless, infection by

means of these food-articles can and does occur, and the precautions against the sale of tuberculous meat and milk are wise and salutary. Observations made in New York and elsewhere on the type of bacilli found in series of cases of tuberculosis of children indicate that about seven per cent of the cases were caused by bacilli of the "bovine type." Wild or range cattle are much less subject to the disease than high-bred, stabled cattle, and many other animals that suffer from it in captivity are free from it in their native wild state, thus showing the predisposing influence of confinement and crowding.

Tuberculosis is rather common also in pigs, dogs, and cats, less so in sheep and goats. The disease may be transmitted by the flesh of pigs. Pet animals, such as dogs and cats, are apt to contract and spread the infection because of their habits of licking up sputum and other discharges to which they may have access. This furnishes another argument for the proper care and destruction of all tuberculous discharges. The urine and fecal discharges of men or animals that have tuberculosis may contain the bacilli and may constitute serious dangers. Thus a cow that is passing the germs in these ways may indirectly infect sound cattle or their milk by means of bacilli blown about the stable with the dust of dried feces or urine, or by soiling the pasturage.

Fish and birds also have tuberculosis, but it is doubtful if the forms of it that they have can be transferred to man. It is not, however, necessary to go to the extreme lengths that fear may carry one in the efforts to avoid tuberculosis. Patients with the disease need to be taught to take proper precautions as to the disposal of their spit and other excreta, but when they take such precautions they need not be avoided. In fact, among

investigators of tuberculosis there is a growing and pretty widely accepted belief that practically all persons become infected with the disease early in life, and that the large majority overcome it. Its appearance in later life is then credited to a lowering of general bodily resistance, rather than to a recent infection. This accounts for the "predisposing" influence of typhoid and measles, they lower the resistance to an infection that already exists. Tuberculous milk is best avoided, but if the milk is not known to be infected, but is merely of unknown or doubtful origin, it can be rendered safe by boiling or pasteurization. The indiscriminate sale of tuberculous meat is properly forbidden by law; but if an animal is not badly diseased and the visibly injured portions of the carcass are rejected, the rest can be eaten with safety if it is first properly cooked. Such meat is not purchased for the army, however, and the above statement is made for its general worth and not to encourage the acceptance of inferior stores.

Anthrax is a disease that causes a very great number of deaths in cattle and sheep in various parts of the world. Other animals are also susceptible to it in varying degrees, among them being horses, deer, pigs, mice, and rabbits. Man suffers from it in two or three forms, generally obtaining his infection from the hides of animals dying of it. Wool-sorters and hide-handlers are therefore particularly subject to it, and one common name of the trouble is "wool-sorters' disease." Soldiers have also been known to be infected (though not in our army) through the use of sheepskin-lined coats, or boots made of poorly cured leather. The disease is often fatal, and materials from animals dead of it should not be used. It is caused by one of the spore-forming bacilli,

and the spores are very resistant to both heat and chemicals. Human infection takes place in two ways; through cuts or abrasions brought into contact with infected skins, carcasses, or other matters, and by inhalation of hairs, bits of wool, or dust that carry the spores. A good many cases arose in our recent draft army from infections derived from shaving-brushes which were evidently made from the hair of animals which had had the disease.

Man is the occasional subject of some other diseases of animals, and it is a good general rule to take as much care to prevent infection from a sick animal as from a sick person, unless the disease is known to be one, such as rinderpest, to which persons are not liable.

Domestic animals are also occasional carriers of common human diseases. Dogs and cats have been known to have diphtheria. Cats have been experimentally infected with whooping-cough, and there is reason to suspect that either of these animals might carry the contagium of such diseases as smallpox, scarlet fever, or measles in its hair. The liability of getting ringworms and other skin diseases, as well as lice and fleas, from domestic animals has already been mentioned.

Insect carriers. Insects of different kinds transmit diseases in various ways. The first and simplest way is by acting as *simple carriers.* Thus germs become attached to the legs and bodies of flies alighting on an infected wound or a yaws papule, and these by later alighting on clean wounds or abrasions may leave the germs there and cause infection. Or the transfer may be less direct, as in the case of the fly that goes from a typhoid stool to a food-article and there leaves germs to be later ingested with the food. In other instances the

simple deposit of the germs may not insure infection, but the irritation caused by the insects may further it. This is well shown in the case of plague. The flea transmitting that disease may do so by reason of the fact that the germs are adhering to its mouth-parts and are introduced directly by the biting act or, as has recently been shown, the germs imbibed at a previous feed may have been so multiplied in the flea's stomach as to obstruct the opening into it, with the result that when the insect attempts to feed again the pumping motions that it makes simply draw the blood into the œsophagus, whence, laden with plague bacilli, it flows back into the wound. On the other hand, the mouth and external parts of the flea may be free from germs, in which case infection may occur as follows: The flea has a habit of defecating while it sucks blood, probably to make room for a larger meal, and in so doing it may deposit plague-germs on the skin, near but not in the wound. If, now, the bite is rubbed or scratched, as is often the case, the germs may in that way get into the wound and infection be assured. An insect transmitting the disease in this last described manner is called a contaminative carrier, and there are some diseases, as relapsing fever carried by body lice, in which that and the rubbing in of the contents of crushed lice, seem to be the only method of infection, the bite alone being harmless.

More complicated processes are involved in other instances, as in malaria, yellow fever, or filariasis, in which the parasites must undergo a cycle of development in the insect; and the latter cannot transmit the disease until a sufficient time has elapsed to allow that to occur. Some insects can transmit germs, and the capacity to convey

infection to man or other animals, to their offspring. This fact has long been known regarding the tick that transmits Texas fever to cattle, and it has more recently been proven true as to those infecting man with the spotted or tick fever of Montana and the relapsing or tick fever of Africa. These diseases may be transmitted by the bites of ticks raised from the eggs of those biting infected persons, but which have not themselves ever bitten people or had any other chance than through "heredity" to obtain the infection. The body louse can transmit the cause and power to infect with European relapsing fever to its offspring, and the same sort of thing may be true as to some other insects and diseases. Among proved or probable insect-carriers of general diseases are *flies* of various kinds, several species of *mosquitoes*, sand-flies of some varieties, the *barbiero* of Brazil, *fleas, lice, bedbugs, ticks, mites*, and *roaches*.[1]

Inanimate carriers. Among inanimate carriers of disease, *food, water*, and *milk* have already been mentioned several times. They may serve as the conveying media for practically all infections that can occur through the alimentary canal, including such important ones as tuberculosis, typhoid, cholera, dysentery, diphtheria, scarlet fever, and many others. These articles, and milk especially, offer such opportunities for the multiplication of bacteria that they may convey to the consumer many thousand times as many germs as origi-

[1] A most curious and interesting example of an insect acting as a carrier for another insect has recently been worked out partially in Central and South America. A large fly, *Dermatobia cyaniventris*, the size of the ordinary bluebottle fly, manages in some manner as yet unknown to get its eggs stuck to the side of the thorax of a variety of mosquito, *Janthinosoma lutzi*. When the eggs hatch the larvæ enter the skin of a man through the wound made by the bite of the mosquito, and there develop, causing abscesses or boils.

nally had entrance to them. Thus a can of milk, becoming infected with a few hundred typhoid bacilli from the hands of a farmer-carrier, may, when consumed in a city, ten or twelve hours later, have billions of germs in it, and cause a great many cases of the disease. It is, therefore, important to prevent the access of even *one* disease-germ to such articles, and carelessness in their handling should not be condoned. Fortunately, thorough cooking will destroy disease-germs in all these substances.

Clothing, books, carpets, toys, and other personal and household belongings that have been handled or used by persons ill with such diseases as smallpox, measles, scarlet fever, and diphtheria may serve to convey infection for varying periods of time, periods fortunately not usually very long, and for that reason the disinfection or destruction of such articles is resorted to as a means of preventing the spread of contagion. Such articles as can be boiled or thoroughly steamed can be quite well disinfected, but if facilities are not at hand for sterilizing such large articles as mattresses, they may need to be destroyed. Boots, hats, and certain other classes of articles will not stand steaming and may have to be disinfected with chemicals or destroyed, though in most instances exposure of them to the sun and fresh air for some days would render them safe. In fact, there has accumulated a mass of evidence to show that terminal disinfection of houses and of inanimate things in general is much less important in the suppression of infectious disease than was formerly thought to be the case, though prompt disinfection of things used during the actual sickness, such as spoons, bedding, and utensils, is thought as important as ever.

Such articles of personal belongings are also common carriers of the organisms of suppuration. So widespread are such germs that almost everything in common use has them on it; and if brought into contact with a wound they will leave the article and start infection. This alone makes the sterilized and sealed first-aid packet of so much greater value than articles of clothing and handkerchiefs as first dressings for wounds. The packets, if not contaminated by handling, practically never cause infection; the other articles almost always do so. Nails, bullets, knives, and other missiles or weapons that have not been sterilized may infect the wounds they cause; or, if sterile themselves, may carry infection from the skin or clothing they traverse.

PART III

THE PREVENTION AND CONTROL OF EPIDEMICS

Thou shalt not be afraid . . . for the pestilence that walketh in darkness: nor for the destruction that wasteth at noonday. PSALM 91 : 56

CHAPTER XI

THE DEFENSES AGAINST DISEASE IN GENERAL

Fortunately for the human race, the contracting and development of disease are somewhat difficult matters, and only follow the occurrence of certain trains of circumstances. They may be compared with the defeat of an army, for which purpose it is necessary that the army become weakened by loss of men, hard marching, lack of food, exposure, or some other cause; or that the enemy has been able to bring a superior force on the field, that his supplies are better or are more promptly delivered; that one side improves its opportunities for offense or defense and the other does not; or that other good and sufficient reasons are present. The mere existence or contact of two armies does not explain that a certain one of them is defeated. So in the matter of sickness, the mere existence or contact of a man and typhoid organisms is not in itself sufficient to insure that the man has or will get typhoid fever. For that purpose it is necessary that the germs shall be alive, virulent, and capable of development, that they shall gain entrance to the body of the man in sufficient numbers, that the man's body shall be unable to destroy them before they have time to develop and liberate their poisons, and that his tissues shall unite with such poisons after they are liberated. It is relatively rare that these conditions coexist, and typhoid fever is therefore not more common than it is. Our defense against sickness then rests on our ability

to break or destroy the chain of disease-favoring circumstances. If we can entirely destroy it, we are sure to remain well, but if we cannot do that, the destruction of one link may save us. It is well, therefore, that we should first consider general plans of defense or aggression, and later pass to the discussion of special campaigns or battles.

Natural defenses of the body. The body is defended from disease by many natural factors, and we should try to preserve these intact. The *skin* presents an impassable barrier to most organisms, and very few infections can enter through it as long as it remains unbroken. It has weak points, however, and infections may occur in the hair-follicles or in the skin-glands. Boils are the commonest results of such invasions. The organisms of typhoid, tuberculosis, and many other diseases could be put on the sound skin with impunity, if they did not later gain entrance to the nose, mouth, wounds, or other openings.

The *mucous membranes* are all warm and moist, and, in that way, offer favorable conditions for bacterial growth; but they are all covered with *mucus* to which the germs may adhere, and with which they may be passed out of the body by spitting or otherwise. The cells lining some mucous surfaces have little, moving, hair-like projections, and by means of these are able to pass along and expel small foreign bodies getting on them.

The *gastric juice* is sufficiently acid to destroy many varieties of micro-organisms, and digestive disturbances that lessen that acidity increase the liability to infection. The fluid also has the power of neutralizing or digesting some poisonous products, but not all.

The *urine* by its acidity and its irrigating and cleansing action, doubtless has an effect in keeping down the number of cases of venereal diseases.

The prompt *reaction to irritation* is often a disease-preventing factor. A dose of arsenic or a meal of tainted meat may produce such prompt vomiting as to cause the expulsion of all poison, and so prevent further symptoms. The inflammatory reaction following the infection of wounds is usually a conservative process that limits the infection to the locality of the wound, and prevents its diffusion through the body.

Immunity. As stated before, however, a man may possess an *immunity* to certain diseases even though the germs gain entrance to his body in the numbers and of the virulence ordinarily producing such diseases. This may be hereditary or "*natural*" immunity, when the man is born without susceptibility to the disease. It is *acquired* when due to something occurring after birth. Acquired immunity is usually due to an attack of the disease, and is well recognized in such affections as smallpox, measles, scarlatina, and typhoid. It is common knowledge that one attack of any of these usually protects against a second. This is also known as *active* immunity, because the body is active in maintaining it. *Passive* immunity is due to the introduction into the body of ready-made immunizing substances, such as diphtheria antitoxin, that is contained in the blood-serum of an immunized horse. Active acquired immunity may also be induced by *vaccination*, the procedure whereby disease-producing organisms in an attenuated or weakened state are introduced into the body and set up a very mild form of disease, but one sufficient to set the body on the defensive and cause it to produce im-

munizing substances. This procedure is best known in its relation to smallpox, and as that was the disease for whose prevention it was first used, the name vaccination in the broad sense, that is, the introduction of disease-producing germs to produce immunity, is taken from that instance. It has also been used, though, to produce immunity to cholera, plague, dysentery, typhoid fever, hydrophobia, and several diseases of animals, in some instances with considerable success.

Immunity may also be relative or absolute, temporary or permanent. Man's lack of susceptibility to the pleuro-pneumonia of cattle, for instance, is both *permanent* and *absolute*. An attack of smallpox may produce an immunity that is either *permanent* or *temporary*. In the latter instance the sufferer might have a second attack after some years. A *relative* immunity to typhoid might protect against a small number of bacteria, but not against a very large number. Relative immunity partially protects races long resident in malarious regions from the more severe or urgent manifestations of that disease. This particular form of it is probably partly acquired as the result of the prolonged exercise by the body of its resisting powers, and partly inherited and due to the survival of the more resistant individuals and the transmission to their progeny of their resistant qualities. In most highly malarious regions the natives are practically all infected, yet they appear to be in fair health, but foreigners going among them are apt to be attacked by malaria in its most severe and dangerous forms.

Immunity is due to several factors, not all of which are understood. In regard to some diseases, such as diphtheria and tetanus, it is due to the development of

antitoxin, a substance that acts as a direct antidote to the poison of the disease and neutralizes its effects. In other instances, as in the case of plague, cholera, and typhoid, it is largely due to the presence or development of substances that kill or dissolve the bacteria. It is probable that it is often due to the ability of the tissues to digest thoroughly the protein of the bacterial bodies and render it harmless, as discussed on the last page of chapter IX. In many instances it is partly or entirely due to the activity of certain cells, phagocytes, that take up and destroy the germs. Absolute hereditary immunity may be due to none of these, but to lack on the part of the body cells of chemical groups that enable the poisons to enter into combination with them.

General health. Relative immunity is maintained by those conditions that keep up the general health and maintain the resistance of the body. It is lowered by causes that depress these, such as starvation, exhaustion, injuries, shocks, worry, and grief. It is therefore important that the man and his environment be constantly kept at their best, that abundant and proper food, pure water, good air, and right clothing be provided, that sufficient exercise to keep the respiration, circulation, digestion, and excretion active be taken; that overwork, improper food, alcoholic and venereal excesses, and the entire list of things predisposing to disease be avoided.

All of these measures tend to strengthen the man and put him in good condition and position for the combat with disease; and, as with armies, so in this instance, the maintenance and strengthening of our own forces is not less important than the weakening or hindering of the enemy; and as the possession of a large and well-trained

army has in past years been spoken of as a "national insurance policy" and a guarantee of peace, so may the well-trained and sound body be regarded as insurance against disease. As the combat with germs is, however, one that never ceases, we must also try to injure the enemy as much as possible, giving no quarter, as we may expect none. We should try to eradicate all disease-producing organisms, to reduce their numbers where we cannot do that, and to weaken them by every means available. Many of the measures designed to accomplish these ends have been mentioned or discussed in preceding chapters or will be taken up more fully in later ones, but some of them may be considered at length here and not again described. They may be classed in two categories: measures designed to prevent contact with the germs, and those aimed at their destruction.

Avoidance of sick. Among the former, avoidance of the sick may be considered one of the most important measures. This recommendation cannot be taken as countenancing neglect of the sick or lack of all proper care and attention, but it refers to unnecessary contact with them, that due to carelessness, curiosity, or sentimentality. As stated before, the principal agent in the dissemination of human diseases is man himself, and nearly every case of infectious disease is derived from another. Therefore, unnecessary visits to hospitals and sick-rooms should be discouraged, and in military life it should be axiomatic that sick men should be removed from squad-rooms, unless good reasons to the contrary exist in special cases.

Ventilation. Even though the sick man goes into a general ward in the hospital, he is less apt to infect others there for several reasons. One of these is that air-space

and ventilation are more liberal there. In the squad-room, where but six hundred cubic feet of space are allowed each person, a sick man may seriously contaminate the air. In hospital the same amount of contagium is diluted two to four times, because the space per man is twelve to twenty-four hundred cubic feet. Naturally an exposed person breathes in only one third as many organisms. Precautions are also taken in hospital to reduce the chances of mediate contact.

Isolation. In the more readily transmissible diseases isolation is resorted to as a means of insuring lack of contact. For this reason it is highly important in such "catching" diseases as smallpox, scarlet fever, and measles, and is of value in the management of typhoid and most other infectious diseases. Both the character and the duration of the isolation vary in different diseases, according to the methods and ease of transmission and the duration of the infectious period. Typhoid and many other infections can be safely isolated in a room or even in a general ward, if proper care is taken in the disposal of excreta, bath-water, and other waste material, in the exclusion of flies and vermin, and in the prevention of mediate contact and the prompt and careful disinfection of the means of such contact, such as bedding, utensils, thermometers, unused foods, nurses' hands, etc. Such care may be necessary for weeks or months. It is usually considered necessary to isolate smallpox cases in a separate house or tent, removed from other houses, and to continue the isolation until the patient is well. The contagion of measles is so readily transmissible that isolation would seem very important, but the period of contagiousness comes so early in the disease that isolation is not effective, because it is not

applied soon enough. In yellow fever, malaria, and dengue the degree of isolation is not necessarily greater than that afforded by the screening required to exclude mosquitoes from the sick, while in typhus and European relapsing fever, both formerly considered so highly contagious, it is only necessary to keep lice from the patient and his visitors.

Quarantine. Infectious diseases of various kinds have different *incubation periods*. These represent the time elapsing between the occurrence of infection, the entrance of the germs into the body, and the appearance of the disease. In some cases of cholera, diphtheria, and a few other diseases, the incubation period may be as short as one day or a few hours; while in hydrophobia it may extend many weeks and possibly months. Diseases also vary as to length of time during which the subjects remain sources of danger after their apparent recovery. Yellow fever, for instance, ceases to be dangerous, to others than the patient, after the third day of its existence; while a typhoid patient may continue to give off immense numbers of virulent organisms and constitute a source of danger to the community for many years.

The term "quarantine," though used in several senses, the oldest meaning a forty-day period of isolation for persons thought to be possible subjects of disease, is now most commonly used to indicate the separation from the general community of persons presumably exposed to infectious disease, and observation of them during the period of incubation of the disease in question. In practice the term is also used to cover the isolation of the sick. Employed rationally and under sound medical advice, quarantine is often a valuable measure and may prevent epidemics. It is one of our main reliances in ex-

cluding plague, cholera, and many other diseases from our ports.

But it is always attended with hardship to its subjects, and when controlled by laymen actuated by panic, fear, or malice, it may become an instrument of cruelty and oppression. Only trained medical officers should direct or control systems of quarantine, and their training should be relied upon to suit the system to the circumstances. A fixed isolation period, say of one month, for yellow fever and scarlet fever, would be wrong in both instances, but in the one the patient would be unjustly treated, in the other, the public.

Police and engineering works. In addition to the matters of barrack, camp, and kitchen police already discussed, larger schemes of policing or engineering are important in the prevention of disease. These embrace such diverse measures as the construction of filtering plants and water-systems to furnish an abundance of pure water, the installation of sewerage-systems and crematories for the removal or destruction of waste, thorough policing and cleaning of streets and neighborhoods to keep down dust or reduce vermin, or the draining, filling, or oiling of marshes to do away with mosquitoes.

Disinfection and sterilization. The best-known and most commonly employed measures for killing germs are usually spoken of as disinfection and sterilization. The terms are not synonymous, though often used as if they were. When an article is sterile in the bacteriological sense, it is free from all germs. Disinfection may free it from all germs, but does not necessarily do so. It means the destruction of infectious organisms. A urinal or bedpan contaminated by use by a typhoid

patient might be disinfected by simply rinsing in hot water, as the typhoid germs are killed in a few minutes by a temperature of 70° C. It would certainly not be sterile.

Heat is the most reliable of the means of sterilization of small inanimate objects. It may be applied moist or dry, the former effective at much lower degrees than the latter. Boiling water or streaming steam, both of which have a temperature of 100° C., will destroy all kinds of growing germs in a short time, while dry heat of 200° C. is necessary to accomplish the same purpose. As this temperature will burn fabrics and is dangerous, it is not much used. Boiling is simple and is easily applied to small articles, so that it is commonly resorted to where special appliances are not available. In hospitals steam sterilization is more often resorted to, as being more convenient and not necessitating so much handling and drying of articles. Large institutions also have steam-chests of sufficient size to receive such bulky articles as mattresses, carpets, and other household furnishings, which may thus be quickly and thoroughly disinfected. Gases and solutions of chemicals are also used for disinfecting; the former for rooms, furnishings, or clothing that would be injured by heat, and to penetrate into cracks and crevices not otherwise accessible. As many of these substances possess disagreeable odors, or have the property of destroying smells, the lay public at times displays a tendency to confuse *deodorization and fumigation* with disinfection. The three may coexist, but they are not the same, and the words should not be used loosely, as such usage may lead to confusion of the processes and so do harm. Charcoal is a good deodorant, and burning tobacco or pyrethrum may furnish efficient

fumigation in ridding a house of mosquitoes, but none of these is disinfectant. The principal gaseous disinfectants are chlorine, sulphur fumes, and formaldehyde. All of them are very irritant and unsuitable for use in efficient concentration in rooms or places where they will be inhaled.

Chlorine is not commonly used in its gaseous state, and when "chloride of lime" is sprinkled about it is liberated in such small amounts as to be inefficient. In watery solution it is valuable in disinfecting surfaces to which it can be applied. It is a powerful bleaching agent, and cannot be used on fabrics. Of recent years this substance has come into very wide use as a purifier of water. Many cities use it, and its use by troops in the field has already been discussed.

Burning sulphur gives off fumes which unite with water to form sulphurous acid, a very efficient disinfectant. The dry fumes have very little virtue of the kind, but are very useful in destroying vermin, such as flies, mosquitoes, and rats. When it is desired, however, to disinfect a room that has been occupied by a case of contagious disease, such as scarlet fever, by means of sulphurous fumes, the walls, floors, and other surfaces should first be moistened by wiping them with a damp rag, or in some other way. As sulphurous acid also bleaches or fades fabrics, it is frequently not to be used except at great expense.

Formaldehyde gas, or its forty per cent solution in water, known as formol or formalin, is now more often used than any other gaseous disinfectant. The gas may be generated in the room to be disinfected by burning wood alcohol in special burners known as formaldehyde generators, or it may be liberated by the evaporation of

formalin. The latter is a very simple procedure, and while its effectiveness cannot be guaranteed, the same may be said of other gaseous disinfection, and it is often the best available means. Many methods of formaldehyde disinfection have been used, but only the use of formalin will be described here. For disinfecting the contents of trunks and boxes, it may be sprinkled over them freely, or placed on absorbent cotton or blotting-paper and the boxes then closed tightly for twenty-four hours. For the disinfection of rooms, from four ounces to a pint of formalin should be used for each thousand feet of cubic contents. The gas is speedily liberated if six ounces of permanganate of potash be added to the pint of formalin in a large bowl, or if unslaked lime be added, or if the fluid be poured on hot bricks. A still simpler and quite efficient method, however, is to close hermetically all cracks and crevices about the room, stretch ropes or strings across it and on them hang sheets. The formalin is then poured upon the sheets to saturate them, and the room tightly closed and kept so for twenty-four hours or more, after which it should be well opened and aired, to rid it of all fumes.

None of the gaseous disinfectants can be depended upon to penetrate thoroughly into large and thick articles such as mattresses. Their action is apt to be superficial, and it is therefore important that the articles in a room to be disinfected be disposed in such a manner as to expose as much surface as possible. Bedding should be taken out of piles and hung on ropes or racks, pictures removed from walls, books opened so as to expose all pages if possible, pockets turned inside out, and all boxes opened.

Formaldehyde is less harmful to fabrics and colors

than the other gaseous disinfectants, and is altogether the most satisfactory for ordinary use, except that it cannot be depended upon to kill insects and vermin.

Fluid and solid chemicals, the latter in solution, are much used as *germicides, disinfectants,* or *antiseptics.* The number of substances so used is large, some of the more important of them being the various *acids, permanganate of potash, peroxide of hydrogen,* and those to be discussed.

Bichloride of mercury, or *corrosive sublimate,* is probably the most important, and for many purposes the most valuable, antiseptic drug. It is used in watery solution of various strengths. A solution as weak as one part in one million has some value, but it is generally used in strengths varying from one part in five hundred to one in five thousand, and in such dilution is a very powerful antiseptic, killing most germs in a few minutes. It has attained popularity, and is commonly sold in tablets of such size that one added to a pint of water makes a one to one thousand solution. The main objections to bichloride are that it is a powerful and deadly poison, and the tablets in which it is sold may, by mistake, be taken for other substances; and that it corrodes and injures metals with which it may come in contact. It works more efficiently when combined with an acid, and the tablets are usually such combinations.

Carbolic acid, or *phenol,* is quite as well, if not better, known as an antiseptic. It is not so powerful as bichloride, and is used in solution of from one to five per cent strength. Occasionally it is used in what is called its "pure" form, about ninety-five per cent strength. It is a very deadly poison, but it does not corrode metals as does bichloride, and is therefore better for disinfecting

them. Both of these substances irritate and injure the hands if much used.

Iodine has long been known as an efficient disinfectant and antiseptic, but it has grown in favor very rapidly in the last few years and is now particularly esteemed for use in disinfecting the skin or the surfaces of wounds, for which purpose the tincture is generally used.

"*Trikresol*" is a disinfectant that is supplied and much used in our military service. It is less readily soluble than phenol, but is equally as powerful a disinfectant when used in half the strength of the solution of the latter. It also is a poison.

There are numbers of mixtures or emulsions made with cresols or crude carbolic as bases, which are both cheap and excellent for many purposes. Many of them, like the *Creolin* issued among veterinary supplies, are proprietary preparations and are sold under trade names. As cheap, efficient, and not secret in composition may be mentioned the official compound cresol solution and the "larvacide" used on the Panama Canal to destroy mosquito larvæ and as a disinfectant.

Formalin is also used as a liquid disinfectant, and for some purposes, such as the disinfection of urine and feces, it is probably the most valuable one we have. It should be thoroughly mixed with a stool to be disinfected, lumps of feces broken up, and the two allowed to stand in contact for a time. Formalin is also a valuable deodorizer.

Medicines. For a few diseases we have remedies that may be termed *specific*, or truly curative. In most infectious diseases, however, we are at best able to modify the course of the affection, to relieve symptoms and

maintain the strength and vitality until nature, or the body forces, accomplishes a cure; and even the specifics cannot always be given in such a way that they get at and destroy all the organisms of disease.

Quinine is a specific for malaria, and actually destroys the growing and multiplying organisms in the blood. Yet men occasionally die of malaria in spite of quinine, and many hundreds of army men can testify that quinine does not always effect a prompt and permanent cure of the disease.

Mercury is a specific for syphilis. It kills the organisms causing the disease, and causes the lesions to heal; yet the men who have devoted the most attention and study to the subject agree that treatment must be continued from two to four years in order to assure a cure.

The drug known as "*salvarsan*" or "606," which was introduced a few years ago as a specific for syphilis, is actually such, and it destroys the causative organisms with great rapidity. However, it is apparently unable to reach them all, and world-wide use of it, while proving its value, has only destroyed the hope at one time cherished, that one injection could be depended upon to cure the disease.

Antitoxin is a specific for diphtheria, neutralizing the poison and making it harmless. Yet, if it be not given early and the toxin has a chance to unite with the tissues, it may fail, and death result in spite of its use.

Altogether, the consideration of specific remedies cannot but convince us that the prevention of disease is of much more importance and value than its treatment, and that the tendency, often manifested, to regard the medical officer as one whose main office is the treatment of men already sick, one who should have nothing to do

with the general administration of a post or an army, is a very grave mistake. Specifics are very valuable, however, in the prevention of disease. Mosquitoes are not apt to obtain infection from the blood of men taking quinine. The man who is under treatment for syphilis is less apt to transmit it than the infected man who is untreated, and the prompt use of mercurial inunctions after intercourse has been shown to be of value in the prevention of infection. "Fourth of July" tetanus, at one time all too common, was very greatly reduced by the routine use of tetanus antitoxin after injuries caused by fireworks.

CHAPTER XII

DISEASES DUE TO INFECTION THROUGH THE ALIMENTARY TRACT

TYPHOID and para-typhoid fevers, cholera, dysentery, and "camp diarrhœa," which is apt to be typhoid or dysentery, may be conveyed in other ways than are indicated by the heading of this chapter. Typhoid, for instance, may be produced by injection of the living organisms beneath the skin. In general, though, these diseases come from the ingestion of the causative organisms by way of the alimentary canal. The germs are in the vast majority of instances introduced in or on food or drink. For many years water was considered the principal medium for the introduction, and it is still recognized as a very important factor. Of late years, however, so many cases, and even large epidemics, have been traced to infected foods and so many more to contact that it is really considered misleading to speak of these merely as "water-borne" diseases.

In addition to the acute infections mentioned above, there are a number of others that enter by the same route. Tuberculosis does so at times, possibly in a large proportion of cases; many "acute food poisonings" are properly alimentary tract infections; "milk sickness" is due to infection with germs contained in milk from diseased cows; Malta fever to germs in the milk of goats infected with that disease; infestations with many varieties of intestinal worms occur by way of the mouth and some of the diseases to be later described as entering by

way of the respiratory tract, such as diphtheria, are known to be carried in infected milk. It is conceivable, though doubtless uncommon, that typhoid or cholera organisms may enter the body through inhalation, and in the throat pass to the alimentary tract and be swallowed. In fact the throat, where diphtheria, scarlet fever, and a number of other infections are apt to localize, is common to both the alimentary and the respiratory tracts, and it is not always possible to say by which tract an infection enters. However, it is generally correct to speak of the diseases here discussed as entering by the alimentary tract, and it has been found in practice that the other avenues may be neglected without great danger.

These have always constituted a very important group of diseases, particularly for military men, and in ancient and modern times, and in all of our wars, clear down to and including the war with Spain and the later Philippine insurrection, typhoid and dysentery did more damage than did hostile arms. As our knowledge in regard to them has grown and we have learned of their causes and the subtle and manifold methods of transmission, we have been more and more able to avoid them, and if they ever again cause such morbidity as they have in the past, it will be because of neglect or of circumstances beyond control, and not because of ignorance. As showing how great a scourge typhoid has been to us even in recent years, and after the method of water carriage of the disease was well understood, may be quoted the official, and it is thought conservative, statement that "About one fifth of the soldiers in the national encampments in the United States in 1898 developed typhoid fever. Among 107,973 officers and men in

92 regiments, the records of which we have carefully studied, the number of cases of typhoid fever, according to our estimates, was 20,738." The above is from the report of the "Board on the Origin and Spread of Typhoid Fever in United States Military Camps during the Spanish War of 1898," of which board the late Major Walter Reed was president. That report gave an impetus to the investigations that have since so greatly increased our knowledge of the disease and of the means of preventing it as to give rise to the lively hope that such conditions as the board investigated may never recur. Nevertheless cholera, which is equally well understood and preventable, did great damage to troops so recently as the late war in the Balkans.

Typhoid fever [1] will be taken as the type disease for this chapter, because it has been of such great military importance in our own service, and because it has so recently been almost eliminated from that service, and it may well serve as a striking object lesson in hygiene, but the general statements made are applicable to the other infections that are transmitted in a similar manner.

Causes. The exciting causes of these diseases are as follows: Typhoid fever is caused by a bacillus that is found in the bowels, gall-bladder, blood, and internal organs of those having the disease. It is an actively motile organism, does not form spores, is easily killed by heat, and does not, under natural conditions, produce disease in other animals than man. Cholera is caused by a vibrio or spirillum, a spiral bacterium that occurs in

[1] Para-typhoid, of which at least two varieties exist, has only been separated from typhoid for a few years, and even now the diagnosis rests entirely on the identification of the causative bacilli, which in turn bears a close resemblance to one another. For this reason most statistics and descriptions of typhoid also include para-typhoid.

the intestinal discharges and contents of persons having the disease. It is actively motile, multiplies with great rapidity, and in so doing the spirals break into comma-shaped fragments, whence the name *comma bacillus*. It does not form spores, is easily killed by heat and acids, and succumbs to the action of sunlight more promptly than most other organisms. Dysentery is a name applied to a group of symptoms rather than to one specific disease. Consequently it is due to several causes. One class of cases is caused by a group of closely related bacilli that present some differences, another to an amœba, an animal parasite, and still others to other microscopic animal parasites. Intestinal infestations with worms have already been discussed.

Origin of epidemics. Every case of any of these diseases is derived from some other case. We may at times have great difficulty in tracing the origin of given cases, but the more we learn about the diseases the more evident the truth of the preceding sentence becomes. Diet and unsanitary conditions promote the spread of, but cannot originate, typhoid. The germs must be introduced by man and are so introduced. The man who first brings infection to a camp may have the fever and not know what is the matter; he may be recovering from it and still not know, or he may have had it and recovered long before, but be a "carrier" and continue excreting bacilli for years. As showing the prevalence of typhoid fever in the general population of the United States in 1898, the following conclusions of the Reed Board are of great interest:

(1) During the Spanish War of 1898 every regiment constituting the First, Second, Third, Fourth, Fifth, and Seventh Army Corps developed typhoid fever.

(2) More than ninety per cent of the volunteer regiments developed typhoid fever within eight weeks after going into camp.

(3) Typhoid fever developed also in certain regular regiments within three to five weeks after going into camp.

(4) Typhoid fever became epidemic both in the small encampments of not more than one regiment and in the larger ones consisting of one or more corps.

(5) Typhoid fever became epidemic in camps located in the Northern as well as in those located in the Southern States.

(6) Typhoid fever is so widely distributed in this country that one or more cases are likely to appear in any regiment within eight weeks after assembly.

(7) Typhoid fever usually appears in military expeditions within eight weeks after assembly.

Because of increase of knowledge of the methods of transmission, and the dissemination of that knowledge by state and local boards of health, by doctors, societies, magazines, and newspapers, because of improved water supplies, sewage disposal, anti-fly campaigns, and other advances since that time, the general conditions are not nearly so bad as they were then, while experience has demonstrated that introduced typhoid is not now allowed to spread as it then did. The improvement in general conditions is not limited to our own country, nor do we lead in it. In fact, we have been behind both England and Germany in much public health work, and the latter nation has long led the world in its low typhoid rate.[1] America's bad showing was probably dependent on several factors, prominent

[1] Professor Max Rubner, Director of the Hygienic Institute, University of Berlin, said in 1913, "As a young man I saw the mighty typhoid fever epidemics in our country, especially in Munich, my native town, which formerly decimated the population: to-day typhoid fever has diminished, as I have been told by a clinical friend, until there is not sufficient typhoid fever for the clinical lectures."

among them being (1) our very widely scattered population, (2) the great extension of typhoid to all parts of the country by soldiers of the Civil War, (3) poorer and less enlightened medical and public health service than in Germany, (4) ignorance and indifference on the part of the public. The first of these factors still obtains, though modified by improved facilities for transportation, the influence of the second is beginning to yield to opposition, the third is being corrected as rapidly as may be expected, and that the fourth follows the third is shown by the generous support now given by the public to many movements for the improvement of health, by the prominence given such subjects by the papers and magazines, and by the fact that many line officers do know and all have it in their power to know more concerning the methods of spread and the means of prevention of typhoid than did the medical officers of 1898.

METHODS OF TRANSMISSION

Carriers. Investigators generally now regard sick and healthy carriers as the source of typhoid, while some of the most eminent of them regard endemic typhoid, that is, typhoid always present in a place, as nearly always due to healthy, chronic carriers. A carrier of typhoid is a person who passes the living and virulent bacilli from his body, usually in his feces or urine, in such a condition that they may infect other persons. The carrier may be just entering on the disease, may be very sick with it, or may be in good health. In the last-named instance he may have had the disease and recovered from it, or he may be merely a "contact carrier," a person who has obtained the germs from another case and in whom they multiply, but one who has never been sick with the dis-

ease. Ordinarily the term "carrier" is used as meaning a chronic carrier and well person, but a person in the early stages of the disease, who continues at his work, is quite as dangerous, and some of the most serious typhoid epidemics of recent years have been due to carriers of this type. This includes the cases of "walking typhoid."

As tending to show how commonly infected persons continue at their usual work, the following conclusions of the Reed Board may be quoted here:

(43) In addition to the recognized cases of typhoid fever, there were many short or abortive attacks of this disease which were generally diagnosed as some forms of malarial fever.

Since that time the methods of diagnosis have so greatly improved that the disease can be detected with much more certainty and much earlier, with resulting improvement in its control, but even yet early cases are a source of great danger, for the reason that diagnosis is not always sought early by the patient, who is apt to think that he has only a bit of indigestion or a cold. An examination of the blood of every patient showing any sort of febrile intestinal disturbance at Val de Grace in 1907, '08, and '09 showed typhoid bacilli in forty per cent of them, though in many there were no other symptoms suggesting typhoid. The actually bedfast patient is less apt to spread the disease widely because of the limitation of his activities. Except that his dejecta may be disposed of so carelessly as to infect water supplies, he is mainly dangerous to his attendants.

The chronic carrier, however, is a menace to nearly all with whom he deals or comes in contact, because neither he nor they suspect that he is a source of danger. Since the investigation of the first recognized chronic carrier,

many interesting cases have been studied and their histories worked out, and, as they illustrate the dangers from this source, a few of them will be detailed. The first case reported was that of the female proprietor of a bakery in Strassburg. All of her employees would sooner or later get typhoid, and the cause could not be located. It was at length ascertained that the woman, who had had typhoid ten years previously, was still passing very large numbers of typhoid bacilli in her stools. In a British reformatory there had been intermittent outbreaks of typhoid, three, four, or five cases occurring at a time. Inquiry pointed to milk as the cause, but inspection of the dairy and its surroundings showed good sanitary conditions. Nevertheless the disease continued to appear. Search among those handling the milk in the institution led to the examination of a girl who had had typhoid six years previously. Two examinations of her stools were negative, but the third showed that she was passing typhoid bacilli. Her removal from the kitchen ended the epidemics.

The first instance thoroughly worked up in America was a very instructive one. The investigation began with the efforts to trace a small epidemic, six persons in a household of eleven being attacked with the disease. Thorough investigation at the time of this outbreak and for some time subsequently failed to disclose the source of infection in the food, drink, or general sanitary conditions. At length suspicion was directed to a cook who had worked in the house for a few weeks, beginning about three weeks before the appearance of the disease. With great difficulty Dr. George A. Soper was able to trace part of her history during a period of ten years, in which she was known to have lived in eight families

where inquiries could be made. In seven of these she had been associated with typhoid outbreaks, always escaping the disease herself. In the seven families there were twenty-six cases of typhoid, with one death. Owing to the cook's refusal to tell anything about herself, and the fragmentary character of the history obtained, it is probable that she had been associated with other cases. On the information obtained, however, the New York Department of Health caused her removal to the Detention Hospital, where she was examined, in spite of her objections and resistance, and was found to be passing great numbers of typhoid germs in her feces.

Another striking case is reported from Prussia, where typhoid had been epidemic on a large estate for fourteen years. During that time there had been thirty-two cases of the disease among one hundred and eighty persons on the estate. Investigations focused attention on the dairy, all of the persons involved having used milk from it. A woman employed there had had typhoid seventeen years before, and the bacteria were found in her stools almost to the exclusion of other varieties. She had worked in the dairy fourteen years, and had been spreading the disease during that time. Instances of epidemics caused by chronic carriers have been very numerous and such carriers are well recognized as one of the more common causes of epidemics. Usually the epidemic is due to the fact that the carrier deals in or handles food for other persons. That such is not always the case, however, is shown by such instances as the following: A nursing mother had typhoid and her infant was taken to a friend's house. The child had a slight diarrhœa but was being weaned, and no particular attention was paid to

this until, one after another, six members of the friend's family developed typhoid. Examination of the child's blood then showed that it had typhoid.

The case of a sailor investigated in San Francisco is of striking interest. In three years and seven months there were twenty-six cases of typhoid on a ship whose crew numbered twenty-one men, and this sailor, who had had typhoid four years before, was found to be a carrier and almost certainly responsible, though he did not handle foods as cook or kitchen helper. The close and intimate contact of life on a small vessel gave him the opportunity to spread the infection. A case known to the writer has suggested the thought that a prostitute who happened to be also a chronic carrier might scatter the disease by plying her trade. Conversely, as the infection in male carriers is at times localized in the seminal vesicles, it is possible that such a one might infect the female having intercourse with him.

Still, as said before, the danger usually comes through contamination of food, and the very great importance of cleanliness on the part of cooks and other persons handling foods, and the necessity of investigating the kitchen in the case of company outbreaks, should always be borne in mind. A severe company outbreak at Fort D. A. Russell in 1909 was found to be due to contamination of food by men working on kitchen police while in the early stages of the disease.

About five per cent of typhoid cases are carriers after their recovery. They may remain such for months or for years. Epidemics have been traced to persons who were carriers after attacks occurring more than fifty years previously, and more than one instance of "family predisposition" to typhoid has been traced to a family

grandmother who had been distributing the infection with food prepared for the rising generations.

As already stated, healthy carriers of cholera are well recognized, and epidemics have been traced directly to them. So far as is known, however, they do not remain carriers for many years as do typhoid carriers, eight weeks being a long period. The belief that this is true is strengthened by the history of cholera in Italy in 1911 and 1912. In the former year it caused 7000 deaths, but it died out in the winter and did not reappear in 1912. This would scarcely have been possible with so extensive an outbreak of typhoid. Dysentery carriers are also numerous in some countries, and some of them remain carriers for many years. They are common in the Philippines.

The effort is always made in our military practice, and in the better class of civil institutions, not to discharge typhoid or cholera patients from hospital until repeated examinations of stools and urine have shown that they no longer excrete the causative bacilli.

Water. Water was not found by the Reed Board to be an important factor in the spread of typhoid in the national encampments in 1898; but it has so often been demonstrated as the most important factor in other epidemics, that all authorities agree in considering it one of the first subjects to be investigated in case of any outbreak. This method of transmission is so well recognized and so generally known that it is not necessary to cite any of the very numerous instances showing it. Prior to 1898 practically all of the great epidemics that had been studied were traced to infected drinking-supplies, and the disease was regarded as mainly, if not entirely, water-borne. This fact helps to account for the

size and extent of the great camp epidemics of that year. Cholera and dysentery have also usually been traced to infected water. There is, however, the possibility that both may be transmitted in the other ways to be considered.

The germs may be ingested directly in polluted drinking water, and such is the usual method in large epidemics due to water. The danger in such instances of course increases with the dose of germs, that is, with increase in the degree of pollution or in the length of time the water is used. It may also occur in less obvious ways. Thus, water that is used in clothes-washing or bathing may become infected from the clothing or persons of sick men or carriers, and may later infect the hands or persons of the people handling or using it, or the vessels in which it was contained. Or men may contract the disease by bathing or swimming in infected streams or pools, and inadvertently taking water into their mouths, noses, or, possibly, their eyes.

The influence of water in spreading typhoid is well shown by the drop in typhoid deaths in cities putting in new and good water supplies. The statistics of deaths in fifty such cities showed, upon examination in 1913, very great improvement, the most striking instance of it being in Pittsburg, where the typhoid deaths per 100,000 of population fell from 74.3 to 12.7, and in the districts getting the good water to 5.9.

Ice. The U. S. Public Health Report for August 7, 1914, contains an article on "Safe Ice" which concludes with the following summary:

1. Clear ice is, of itself, as free from the danger of conveying infectious diseases as we need wish.

2. Dirty or cloudy ice may be dangerous. It should not be placed in water nor on food which is to be eaten uncooked.

3. There may be danger in eating iced foods or using iced drinks if the ice is improperly handled when placed in contact with the food or drink.

4. We may eliminate all danger by avoiding the handling of ice with dirty hands, by washing the ice with pure water, and by using only clear ice.

5. The average laboring person does not always have the opportunity, even if he have the inclination, to cleanse his hands after attending to those necessities of nature which require their use for purposes which almost invariably result in their contact with excreta which may contain the organisms of disease, even in apparently healthy people.

It is therefore impossible to overestimate the danger resulting from the handling of ice by unknown persons if the ice is placed in direct contact with drinking water. Consequently in hotels, cars, stations, and similar places where intelligent personal supervision is impossible or impracticable, those furnishing the water should be instructed, and indeed compelled by law, to adopt such means of cooling water as do not require direct contact of ice and water.

Milk. Milk-borne epidemics of typhoid are also well recognized, and many of them have been thoroughly studied. The milk is, in the great majority of instances, contaminated from the hands of milkers, dealers, or other handlers who are suffering from beginning typhoid and have not yet ceased work, who are convalescing from the same disease, or who have had it formerly and are still "carriers." The contamination may occur in other ways, such as the use of infected water for washing cans or diluting milk. It may also linger long in cans once infected, if they are not properly washed and sterilized, as the germs will multiply in milk. As the same thing is true of the germs of cholera and dysentery, they may also be milk-borne.

One of the largest milk-borne epidemics of typhoid fever occurred in the suburbs of Boston in the spring of

1908. Four hundred and ten cases occurred, the infection being traced to a milk-dealer who continued his work for two weeks after the onset of the typhoid fever from which he later died.

An epidemic of 295 cases at Worcester, Massachusetts, in 1911, was traced to milk infected by a carrier who had had typhoid twenty-six years previously. That both of these epidemics are reported from the same state is an indication of the thorough investigations and reports made in that state, and not of any greater prevalence of typhoid there than in other states. Milk was found responsible for the infection of 8.1 per cent of all cases of typhoid in Massachusetts from 1909 to 1919.

Vegetables and other foods. Lettuce, radishes, and other vegetables or fruits that are eaten uncooked may be contaminated by unclean handling, by washing in polluted water, by contact with typhoid feces or urine in manure, by flies, or by infected dust blown and deposited on them. Bread, cool meats, and other food-articles may also be contaminated in some of these ways after they are cooked. Any article so polluted might cause the disease if it were eaten.

An interesting typhoid outbreak in the German army, reported in 1909, was traced to a woman carrier who prepared vegetables in a maneuver camp. The very careful investigation made indicated that 124 men were probably infected, though only 27 of them were sick enough to be classed clinically as typhoid. Yet any or all of them might have been sources of danger to the commands to which they belonged.

The avoidance of uncooked fruit and vegetables from and in places where cholera prevails is a matter of great importance.

Shellfish. Many epidemics of typhoid fever have been traced to the consumption of oysters and other shellfish gathered from sewerage-infected beds. For twenty-five years the city of Belfast had had the greatest mortality from typhoid of all the cities in the United Kingdom, in spite of a good water-supply and good general sanitation. A commission appointed in 1907 to investigate the matter showed that the endemic prevalence of the disease was due to the unrestricted gathering of cockles, mussels, and other shellfish from the "slob-lands" of Belfast Lough, which are laden with the city's sewage. Hundreds of acres are exposed at low tide, and the shellfish are gathered by the poorer classes, who generally eat them raw. The Jews, who do not eat them, were exempt from the disease. It is probable that cholera and dysentery may be transmitted in the same way.

Dishes and implements. Living and virulent typhoid organisms have been found in the mouths of persons sick with the disease, and the vomit of cholera may contain the germs of that ailment. It may therefore be understood that the common use of drinking-cups, clinical thermometers, and other articles that are put to the mouth, may lead to infection. In all of the diseases discussed in this chapter the organisms occur in the intestines, and careless use of rectal syringes may spread them. Such an accident is, of course, more apt to occur in hospitals.

Dust. None of these diseases is air-borne in the sense that smallpox and scarlet fever are, but feces, urine, or other material containing the causative organisms may be scattered as dust when well or partially dried and pulverized, and may be inhaled in that form, or may light on articles of food or drink and be ingested with them. The Reed Board reported:

(31) It is probable that the infection was disseminated to some extent through the air in the form of dust.

(28) Flies undoubtedly served as carriers of the infection. Flies swarmed over infected fecal matter in the pits, and then visited and fed upon food prepared for the soldiers at the mess tents. In some instances where lime had recently been sprinkled over the contents of the pits, flies with their feet whitened with lime were seen walking over the food. It is possible for the fly to carry the typhoid bacillus in two ways. In the first place, fecal matter containing the typhoid germ may adhere to the fly and be mechanically transported. In the second place, it is possible that the typhoid bacillus may be carried in the digestive organs of the fly and be deposited with its excrement.

Flies and other vermin. Several asylum epidemics of dysentery, notably one at the Danvers State Hospital (Massachusetts), have been shown to be spread by flies, and the large annual epidemics in Fiji from December to March have been ascribed to the same agency. A report published in 1919 on the subject of dysentery in the British Expeditionary Forces concluded in part as follows: (1) Bacillary dysentery is most prevalent when flies are most numerous. (2) Flies, after contact with food infected with dysentery bacilli, are capable of carrying and disseminating these bacilli for at least twenty-four hours. (3) Dysentery bacilli were isolated from wild flies captured in places in which bacillary dysentery is both endemic and epidemic. Flies caught during an Indian epidemic of cholera in 1912 were found to have cholera vibrios both on their external appendages and in their intestinal canals.

Recent work in the Philippine Bureau of Science has shown that cockroaches fed on human cholera feces may harbor cholera vibrios in their intestines, and these may appear in enormous numbers in the insect's feces for at

least two days after the feeding, and in smaller numbers for a longer time, and if deposited on human food with the cockroach feces they may there survive for another four days. By means of either feces or vomit from cholera cases the cockroach may carry infection to human food. The same investigation showed that cholera vibrio may be found in the bodies of ants for eight hours after they have ingested feces from cholera patients. There is little room for doubt that both of these insects could carry typhoid, probably more readily than cholera.

It would be well for the line officer to know the following facts concerning house-flies. They breed in horse-manure, human feces, and other filth, and can readily emerge through six inches of loose earth, but not through earth saturated with water. When breeding in feces, the larvæ will go into the earth five or six inches as the feces dries, and there find more congenial surroundings. Flies are naturally most numerous about manure piles, trench latrines, and kitchens, because they find in those places the best breeding and feeding places respectively. The female lays about one hundred and twenty eggs, and the development of these varies with the temperature, in the tropics somewhat as follows:

	Hot Weather Days	Cool Weather Days
Eggs hatch in	1	2
Maggots change to pupæ in	5	14
Pupæ change to adult flies in	3	5
Total	Short 9	long 21 or more

In temperate and cold climates all the stages of the fly's life may be prolonged, so that the full change from adult to adult may require as much as two months, while

adults and possibly pupæ last through the winter and start the cycle again in the spring. The fly does not pupate in a wet medium if the full-grown larvæ can find means of migrating to a dry place protected from the sun; for example, at the edge of the manure pile, under boards, or in cracks. Here the pupal cases may be found as small, brown shells the size of plump grains of wheat, and in great numbers. It has been found that bacteria such as those causing typhoid survive much longer in than on flies, and longer in the insect's gut than in its deposited feces. A study of the flies of New York City in 1911 brought out the following facts that are of interest as bearing on the seasonal occurrence of typhoid and summer diarrhœa (bacillary dysentery). Up to the end of June the flies were found to be practically free from fecal bacteria. During July and August the flies examined carried millions of bacteria, whereas at other seasons they carried hundreds only. Fecal bacteria of the colon bacillus type were first found abundant in July. The bacteria were 8.6 times as numerous in the intestines as on the surface of the flies. Extensive experiments and observations in Cambridge, England, indicate that house-flies tend to travel against or across the wind, apparently attracted by odors. The chief conditions favoring dispersal of flies are fine weather and warm temperature. They do not travel as far in towns as in the country, the maximum flight observed in thickly populated parts of Cambridge being a fourth of a mile, while in the open country single flights may double that.

Contact. Contact with sick persons offers many opportunities for both mediate and immediate infection, and the class of diseases under discussion often infect nurses and attendants. The typhoid patient, as stated

before, may give off the germs of the disease from his bowels, bladder, or, occasionally, his mouth. From these sources the bacilli get on towels, bedding, urinals, chamber pots, the patient's skin, and into bath water. Any of these articles may be handled by nurses, associates, or casual visitors, who may thereby infect their own hands or persons, and later take the germs into the mouth. Persons using the same drinking glasses, linen, or other personal articles, as the sick man, are especially apt to be infected. This method of infection is now regarded as very important. The greatest care in cleanliness and disinfection is necessary on the part of all hospital attendants and others brought in contact with the disease. The danger is of course greater if the nature of the disease is unknown, and the subject pursues his ordinary course of life, eating, drinking, sleeping, defecating, and urinating, with no thought of being a menace to others.

Tent-mates and bed-mates, and members of the same family and household, are particularly exposed. The Reed Board published the following conclusions that bear on the subject:

(30) Typhoid fever, as it developed in the regimental organizations, was characterized by a series of company epidemics, each one having more or less perfectly its own individual characteristics. . . . Of 1608 cases of typhoid fever which we have been able to accurately locate in the particular tents in which they occurred, together with the date of the commencement of the attack, the results may be summarized as follows:

Directly connectable attacks, 563, or 35.01 per cent.

Indirectly connectable attacks, 447, or 27.79 per cent.

Total connectable attacks, 1010, or 62.8 per cent. . . . We believe, therefore, that personal contact was a very important factor, probably the most important, in the spread of the disease.

The Germans, after years of careful and most valuable work by a government commission on typhoid in southwest Germany, regard contact as the main method of spread of the disease. The contact is with the sick, the sickening or the healthy carrier, but usually with one just sickening. The German commission found typhoid bacilli in the blood of an apparently healthy boy of twelve, whose sister, in the same house, had the disease. Four days later the boy sickened. He was a source of danger even before he appeared sick. Examination of six hundred cases of typhoid in the Saar district showed that a large proportion of contact infections must have occurred during or before the first week of sickness of the infecting cases, even assuming the incubation period to be so short as ten days. In fact, more than half of the contact cases seemed to have been infected thus.

Contact infection was the main cause of the spread of cholera in the Bulgarian army in 1913. Recruits neglected to use latrines, soiled the ground, and later infected their hands in removing shoes and clothing.

It will be readily understood that the dangers of contact would be greatly increased by crowding, poor ventilation, and uncleanly habits.

House epidemics of cholera are common in the Philippines during epidemic seasons, and owe their origin and spread to the causes discussed above, to the common use of food and drinking utensils, and to infection contracted in cleaning up vomit and watery stools. There is good reason to think that dysentery and diarrhœa may be spread in the same ways, while it is well known that intestinal worms often are, among children.

The above discussion of the dangers of contact with sick persons may be applied equally well to similar rela-

tions with carriers, except that they are not known to their associates to be sources of danger, and are thereby rendered more harmful. They are more apt than sick men to sleep with other persons, to lend or borrow clothing, to be put on duty in kitchens, or handling foods, or caring for cows, while no precautions are taken in the matters of disinfecting their clothing, stools, or urine.

Soiled shoes. It does not require lengthy argument to demonstrate that, if urine and feces contain disease-producing germs and are deposited on the surface of the ground about camps or are allowed to soil the edges and vicinity of latrines, men may get their shoes soiled with such matters and the contained germs. Such being the case, the contamination might easily be conveyed to tents, bunks, company streets, and the hands of the men. Needless to say, such infection could be conveyed even though all gross evidence of fecal or urinary soiling were removed.

Fomites. The term fomites includes such inanimate articles or substances as are thought capable of absorbing, preserving, and transmitting the contagion of disease, and is used as a general designation for such things as books, clothing, tents, bedding, and baggage. Clothing that is grossly contaminated, such as sheets or shirts soiled by the diarrhœal discharges of sick men, is, of course, most dangerous, but the danger in such cases is apt to be recognized and provision made for it. On the other hand, bedding soiled by dirty shoes, tents that have been urinated upon, the clothing of apparently well carriers, and other articles may be infected and show no signs of it, and so do great harm.

Laundry-workers, hospital attendants, and tent-

mates of the sick are naturally more liable than others to infection in this way; yet all may be exposed to it in time of epidemics.

PREVENTION AND CONTROL

The general measures for the prevention of these diseases are those hygienic precautions that have been discussed in preceding chapters. If cases do begin to appear in a command, it is evident that they have not been sufficient, and more vigorous steps should be taken to protect the men not yet infected. If they show in the neighborhood of the command, or along lines of communication with it, the same active measures should be adopted. The best prospects for the prevention or control of the epidemic will be offered if the following steps be taken.

Early diagnosis. One of the most important of these is early diagnosis of the dangerous cases. As long as their nature is unknown, they continue to disseminate the disease-germs; and such undiagnosed or wrongly diagnosed cases apparently had much to do with the spread of typhoid fever in the camps in 1898. At that time the methods of diagnosis were not so good as at present, and a positive diagnosis of typhoid could not usually be made until after the patient had been sick a week or more. Laboratory methods now permit of it sooner, but they are not always available, and the safe rule is to regard and handle suspected cases as though the disease were known to be typhoid.

The diagnosis is a matter for the medical officer to worry over, but the line officer can be of assistance if he instructs his men to go on sick report if they are not well, and if he does not unduly encourage the notion that men

only seek sick report to escape work. It is at any rate better that two or three frauds should be allowed to loaf for a time than that one sick man should be allowed to spread disease through the command. The Reed Board made the following findings that bear on the difficulties and importance of early diagnosis:

(46) Army surgeons correctly diagnosed about half the cases of typhoid fever.

(14) A man infected with typhoid fever may scatter the infection in every latrine in a regiment before the disease is recognized in himself.

It is an interesting fact that many medical officers during the World War had such an obsessing belief in the efficacy of typhoid vaccine in preventing typhoid that they could not or would not recognize well-marked and typical cases, because they did not think it possible that the men could have typhoid. There were many instances of this blindness, some of them persisting in the face of bacteriological or *post-mortem* proof. It is always necessary to be alert that beliefs do not make us blind to facts.

Isolation. Diagnosis is of no value in the prevention of epidemics unless it leads to immediate steps to prevent infection through contact, soil-pollution, water-pollution, and in other ways. It should therefore lead to the isolation of all recognized or suspected cases, and such measures of care as will prevent their spreading the disease in any of the ways discussed in this chapter. Such measures must include screening from flies, disinfection of clothing and linen, of bath water, dishes and utensils, of stools, urine, and spit. Only the necessary attendants, and they well-trained ones, should have access to the patients. The isolation should at times include suspects

who have been exposed to disease as well as the actually sick. This is particularly true as regards cholera. It is necessary in a less degree for typhoid, and still less for dysentery. Whenever resorted to, such isolation should more than cover the ordinary period of incubation of the disease. Cholera suspects should be isolated for five days, those suspected of typhoid for three weeks or until well and free from bacilli. In the latter disease such strict isolation may not be necessary, but in case of severe epidemics it will be wise, and can be done in isolation camps, where the men can work, drill, and play. At times it may be advisable to quarantine entire organizations as suspects, or to direct the measure against towns or communities.

Compulsory reporting of cases. Isolation cannot be made an effective measure of disease-prevention unless it includes all cases of the disease in question, and, in many instances, all suspected cases. It is, therefore, essential that all cases and suspects be promptly reported to the central authority, in order that proper steps may be taken. It is only rarely that difficulty will arise in this matter as it regards the military personnel; but cases among civilians and residents of the locality in which the troops are quartered may be willfully concealed. Epidemics "hurt business," and often interfere with transportation and traffic, and for this reason and others it is not uncommon that great efforts are made to hide or deny their existence.

Health inspections. It therefore occasionally becomes necessary to make regular and frequent inspections and examinations of all persons in camp, and less frequently of those in the neighborhood. If the community is under military control, this may be a relatively simple matter,

but where such is not the case it may be one of extreme difficulty, and call for the display of much forbearance, good temper, and tact. When such measures are necessary, they should be under the charge and direction of medical officers who will see that they thoroughly accomplish their purpose, but at minimum of inconvenience, and that they are conducted in such a manner as to gain rather than alienate the sympathy and the coöperation of the civil population and its medical practitioners. If many sick are found it may be necessary, in order to control the epidemic, to establish large isolation camps and special hospitals for civilians. The gathering of large crowds from many places, as in pilgrimages, fairs, and religious festivals, should be particularly forbidden during cholera epidemics. Health inspections may also be made the means of much sanitary instruction, and may thus do great good in addition to that accruing from a knowledge of the location of cases. Such inspection, examinations, and instructions have been resorted to in times of cholera epidemics, and among peoples living under military control, with great success. They redound to the benefit of the civil as well as the military population. Inspections of troops for the presence of disease are not infrequently resorted to, and often do much good.

Investigation of cases. Every case of any of these diseases that is reported or discovered should be investigated as thoroughly as possible as to its origin. This investigation may show no results in single cases, but when the findings in many cases are compared they may give important information as to the cause of the epidemic. Thus it may be found that it is confined to persons using a certain water, to those consuming milk

sold by a special dealer, or who eat the productions of a certain cook, or who have partaken of shellfish; or that the cases are otherwise connected in some way. The information thus gained may direct attention to the cause of an epidemic, and its removal may put an end to the whole matter. The tracing of epidemics is, however, often a difficult matter, and the detection of typhoid-carriers is particularly so. If, for instance, a carrier were put on kitchen police for a day and infected the food of a company, a dozen men might contract the disease as a result. They might develop it, however, in from three days to three weeks, or possibly more, and meanwhile a large number of men may have worked in the kitchen, and many other factors having an apparent bearing may have come to light, so that all thought is diverted from the man really causing the trouble. However, the report of a well-studied carrier-caused epidemic of ninety-three cases in Hanford, California, in 1914, showed that more cases developed on the sixth than on any other day, two thirds of all cases appeared by the tenth day, and one case developed in three days.

In very many instances the cause of the epidemic cannot be ascertained, or at least not soon enough to permit its removal in time to prevent numerous infections, and protection must be sought in the practice of such general preventive measures as are applicable. These should take into consideration the various methods in which the diseases are transmitted, and will embrace the following.

General measures. *Cleanliness* of persons, tents, kitchens, and camps is of paramount importance, and officers should encourage it by precept, example, orders, and, if necessary, punishment. Those associated with

the sick should be particularly careful as to their persons, surroundings, and food. They should keep clean tents, wash themselves frequently, disinfect their hands after handling the sick, their bedding, clothing, or other personal belongings, should be careful not to use the same drinking or eating utensils, and in other ways should avoid the dangers of contact. *Disinfection* of clothing, bedding, tents, rooms, barracks, urinals, latrines, and all the things used by the sick man, should follow his removal from the barracks, tent, camp, or temporary hospital. Articles that cannot be well disinfected, such as hats and leather gloves, should be destroyed if grossly infected. Latrines that are infected should be disinfected as well as possible, and, if pits or other cheap arrangements, closed. Great care should be taken to make sure that all latrines are fly-proof. *General good hygiene* should prevail. Sunshine and fresh air should be provided in abundance to destroy and dilute the poison; temperance, order, and regularity of habits encouraged, overwork and idleness alike avoided, and cheerful and rational living enjoyed. The ground should be kept so clean as to leave no opportunity for fecal or urinary contamination of shoes, no breeding-places or food-supplies for flies or roaches, and no infected dust to blow about. The effect of not doing these things is seen more promptly in cholera than in typhoid, because the incubation period in the former is shorter and effects become manifested before causes are forgotten. In that instance, lack of sunshine, intemperance in food and drink, fear, and unhygienic surroundings are regarded as important predisposing causes of the disease. Increased care and attention should be given to the *disposal of feces, urine, vomit,* and other wastes, and to the *elimina-*

tion of flies and other insects and protection from them. *Cremation* of waste materials should be resorted to if practicable. Men should be instructed to use only the latrines and urinals of their own companies so far as it is possible to do so, and under no circumstances to urinate or defecate on the ground. The Reed Board reported:

(15) Camp pollution was the greatest sin committed by the troops in 1898.

Cleanliness of camp-sites and *good general police* are therefore of very great importance, both as preventing accumulations of infective material and as keeping down flies and other vermin. The Reed Board published an important conclusion bearing on this:

(37) The fact that a command expects to change its location does not justify neglect of the proper policing of the ground occupied. . . . A camp-site should be thoroughly policed up to the moment of vacating it. This should be insisted upon as a matter of military discipline, and camp commanders should regard proper attention to the sanitation of the site occupied by their troops as one of their highest duties, and its neglect as a crime.

Recent experiments show that typhoid bacilli can retain their virulence in soil for several weeks or months.

Change of site. When, because of want of foresight, neglect, or for any other reason, a command is located on a polluted site, a change may be desirable. This cannot be depended upon to rid the command of infection; and disinfection, isolation, and the other measures herein advocated must continue to be used, but the change may at any rate reduce the number of channels of infection. The dust blown about camp would be less dangerous, the number of flies smaller, and the opportunities for fecal contaminations fewer, in the new camp.

Water-supply. The water used for drinking, dish-washing, and similar purposes can, of course, be sterilized by boiling; but as many men seek other water to drink, it is desirable that only a pure supply be available, and if one purified by large filtration plants or other means is to be obtained, it should be. At times it may be necessary to take steps to guard the purity of a supply known to be good. Reservoirs, filters, or watersheds may need to be patrolled to prevent their contamination. Bathing in drinking-supplies should of course be prevented. The rule to be followed always in time of epidemics is, however, to drink no water not purified artificially. No matter how good a general supply is to-day, the possibilities of infection are so many, and so hard to guard against, that there is no certainty as to the purity of to-morrow's supply.

Ice, unless made from distilled water and handled with all possible care, should not be allowed to come in contact with articles of food or drink during the prevalence of epidemics. It may contain germs frozen in it, or they may have been deposited on the surface by improper handling.

Food-supply. The safest rule as to foods is the same as that just applied to water — to take none that is not sterilized. This rule is pretty generally applied by Americans in the Philippines, especially during cholera epidemics, but it has not had such general application in our own country or as a measure of defense against typhoid. Heat is the means of sterilization for most foods, and cooking the method of applying it. However, such articles as bananas, mangoes, apples, cucumbers, melons, that are protected by a thick skin or rind, may be washed in bichloride or other antiseptic solution, and later peeled. The use of pies, soft drinks, milk, and

similar articles sold by peddlers, is in general to be deprecated, and it may be advisable to stop such sales. Green vegetables may also have to be banned, particularly in cholera times and where dysentery and the practice of manuring with human feces coexist. If either typhoid or cholera appears in the person or family of a dealer in foodstuff or milk, his business should be stopped at once, or allowed to continue only under such rigid rules as will destroy all chance of dissemination of the infection. If the person cannot be controlled by military authority, the soldiers should be forbidden to deal with him.

Vaccination. Typhoid, cholera, and bacillary dysentery are all diseases in which protective value has been attributed to the injection of the living or killed germs beneath the skin, the procedure commonly spoken of as vaccination against the diseases. Vaccination against dysentery has had relatively little use, but good results have been claimed. The use of cholera vaccine has been much more extensive, and in India, Japan, the Philippines, and elsewhere the results have been considered most encouraging. According to statistics published in 1913 by the originator of the most widely used cholera vaccine, it appears to reduce both the morbidity and death rates to about one seventh of what they are among the unvaccinated.

The latest available figures relating to this vaccine are those concerning its use in the Greek army at the end of the Balkan war. Following an extensive outbreak of cholera in the army and the territory occupied by it, 150,000 troops and 350,000 civilians were vaccinated. The attempt was made to give two injections at an interval of eight days. The immediate effects of the injections were not such as to prevent military duty,

and were probably much like those following the use of our typhoid prophylactic. In the whole army about 19 persons per 1000 developed cholera. Among the unvaccinated the incidence was 93 per 1000 and the mortality was 27.5 per cent of the sick. Among those who had one injection the incidence was 42 per 1000, with a mortality of 12.2 per cent, and among those having two injections it was 7 per 1000 with a mortality of 10.2 per cent. That this entire improvement was due to the use of vaccine is improbable, but how much of it was due to improved measures of sanitation and to the general dissemination of knowledge of the methods of prevention that must have gone into effect as the vaccination progressed is not known.

Typhoid vaccine, or prophylactic, as it is officially designated, has had its most extensive use in our own army, and the results have been so good that its use has there been compulsory and universal since 1911. Typhoid has now practically disappeared from the United States army, its incidence and mortality for twelve years being shown in the following table:

Typhoid Incidence and Deaths per 1000 Persons in the U.S. Army

Year	*Cases*	*Deaths*
1907	3.53	0.19
1908	2.94	0.23
1909	3.03	0.28
1910	2.32	0.16
1911	0.89	0.11
1912	0.26	0.03
1913	0.05	0.0
1914	0.08	.03
1915	0.08	0.0
1916	0.87	.05
1917	0.46	.03
1918	0.34	0.08

Just how much of the reduction shown here is due to the use of prophylactic and how much to other factors it is impossible to say. In his annual report for 1913 the Surgeon General said: "It must be especially emphasized that there has been no lessening of the efforts in the army to prevent, by improved sanitary measures, the occurrence of typhoid infection. Advances in the other sanitary measures have gone on, hand in hand, with the extension of the typhoid prophylaxis."

Recent experience has shown clearly that vaccine alone is not a certain protection against typhoid, and that the same care must be exercised to prevent infection, to get rid of sources of contagion, as before it came into use. Considerable numbers of cases of typhoid among vaccinated men in an epidemic at Schofield Barracks, in concentration camps, and in the armies of the A.E.F. show that, when the chances for obtaining the infection are good, a proportion of vaccinated men will develop the disease. That proportion will be less, however, than among the unvaccinated, and we may reasonably feel that vaccination is a valuable aid in our combat against typhoid. The experiences just referred to are abnormal in a sense, and are not to be taken to indicate that typhoid will ordinarily be more common hereafter than it was in 1913.

The Hawaiian epidemic was due to gross pollution of a water-supply and would have been avoided had proper care been exercised. The A.E.F. typhoid was in part imported from America, but the larger outbreak began in an army fighting in a polluted region where the disease was endemic, under conditions which made impossible the purification of all waters used and the general observance of the well-known sanitary precautions. Once

started it was spread by carriers and by men in the early stages of the disease, and in general presented the picture of an epidemic due to contact infections, with an occasional explosion from a kitchen infection.

CHAPTER XIII

DISEASES DUE TO INFECTION THROUGH THE RESPIRATORY TRACT

To group the diseases discussed in this chapter under the above heading may be somewhat misleading, but as it is thought that all of them do frequently gain admission to the body by way of the respiratory tract, and some of them always, as the above caption is less misleading than the phrase "air-borne diseases," and as the group cannot be considered as conveniently and satisfactorily in the preceding or the following chapters as in this, the grouping is considered justifiable.

Most of those now to be treated of are also known as contagious diseases. The term is elastic and may be used in different senses, but as ordinarily applied to the diseases discussed in this chapter it may be taken to mean that they are more readily transmissible than most others and are very apt to spread, especially by contact or association.

The principal diseases, from a military standpoint, in this group are pneumonia, measles, scarlet fever, German measles, smallpox, chickenpox, influenza or grippe, mumps, whooping-cough, diphtheria, tonsillitis, epidemic meningitis, and acute anterior poliomyelitis or infantile paralysis. It is true, though, that tuberculosis, pneumonic plague, and some other diseases are sometimes widely spread in the same way.

Causative organisms. Some of the diseases mentioned above — tuberculosis, diphtheria, meningitis, tonsillitis,

plague, and whooping-cough — are known to be caused by bacteria, and the organisms can be isolated and identified. The causes of measles, German measles, scarlet fever, and smallpox are still unknown, and it is possible, though not certain, that they are due to organisms invisible with our microscopes. Supposedly causative organisms have been described for each of them, but convincing proof of the relationship has in no instance been produced. Mumps has recently been shown to be due to a filterable virus found in the blood and the saliva of those suffering with the disease, which virus can cause the disease in cats.

The cause of influenza was for many years supposed to be the influenza bacillus, but the last great pandemic (world-wide epidemic) caused such tremendous mortality, especially among the young and strong, as to lead to renewed investigation as to the cause, with the result that many investigators think that it is something other than the influenza bacillus. However, there is not nearly complete agreement on this point and the decision must be left in doubt for the present.

Predisposing causes. Certain factors have an important influence in predisposing to some of these diseases, and enable us to exercise some measure of control over them. Most of them are so prevalent in the *very young* as to be known as "the diseases of childhood." By this phrase we usually speak of the group including mumps, measles, scarlet fever, German measles, chicken-pox, and diphtheria. Before the era of vaccination, smallpox was also principally a disease of childhood, and produced its greatest mortality among those under five years of age. Thus in "Geneva from 1580 to 1760 there were 25,349 deaths from smallpox, and of these 21,078

were under five years old and 961 per 1000 were under ten years old. In Edinburgh in 1764–83, the proportion under ten years old was 993 per 1000. In the Chester epidemic of 1774 there were 202 deaths, all among children under ten years old." All of these diseases do attack adults, however, though less frequently and usually less severely than children.

Season exercises some influence. The cold, raw weather of the late winter and early spring particularly favor most of them, while they are also common in winter and rather rare in summer. Infantile paralysis, however, is more apt to occur in summer than at other times.

Crowding favors epidemics, quite apart from the question of ventilation, and it also predisposes to severe attacks. Many cases of a very severe type of measles developed in the concentration camps in 1898, and an epidemic of six hundred cases occurring at Columbus Barracks between December, 1910, and May, 1912, was thought to have been aggravated by crowding. School epidemics of measles, German measles, scarlet fever, mumps, and diphtheria are rather common.

As stated before, 92 per cent of 45,048 deaths from disease in the army between September 1, 1917, and January 31, 1919, were caused by diseases of this group, and the fact is thought to be directly related to the overcrowding of troops at that time.

Poor hygienic conditions, such as dirty surroundings, the breathing of effluvia from decomposing matter, and bad ventilation, are all thought to predispose to them, and probably do so by reason of the fact that persons exposed to such influences are pretty sure to be living in such a manner as to be subjected to unusual opportunities for too close contact with neighbors.

Unknown atmospheric conditions apparently influence the rise and fall of some of them. Influenza and diphtheria increase and decrease in ways thus far not fully explained. The great influenza pandemic of 1918 and early 1919 affected such widely separated regions as Siberia and the Fiji Islands. It is said to have killed five million people in India in the short space of three months, while in Samoa it killed 7264 of a total native population of 36,405.

A previous attack of one of these diseases usually protects from a second, but such is not the case in all of the group. Second attacks of smallpox, scarlet fever, and mumps are rare, those of measles less so, and those of diphtheria and influenza still less so, but even these confer a temporary immunity.

Methods of transmission. These diseases are not all transmitted in exactly the same way, but the transfer of no one of them is so limited as the title of the chapter would indicate; so the various methods will be considered and the exceptions noted as we progress.

Air. Some of these affections are contagious to such a degree that near approach to the patient and breathing of the air surrounding him in a greater or smaller zone, without any contact, seems sufficient to allow infection. This is particularly true of measles, but it is sufficiently true of all the diseases of the group to make isolation ordinarily worth while as a matter of routine in military practice, and this is none the less true because of the fact that transmission of most of the diseases of the group is by contact, rather than by air-borne infection. The following excellent observations that bear on this point were published in the London *Lancet* of June 13, 1914.

In a common open ward with good ventilation, hav-

ing twelve beds and an allowance of 195 square feet of floor-space and 15 linear feet of wall-space per bed, there were treated in two years 274 patients with 332 cases of contagious diseases, including 112 cases of scarlet fever, 63 of diphtheria, 24 of chickenpox, 47 of whooping cough, 11 of mumps, 2 of incipient measles, 6 of German measles. At such patient's bed were a table, eating utensils, towels, gowns for nurse and doctor, and such things as the patient needed. No toys, books, or other articles that would be apt to be passed from one patient to another were allowed in the ward. On entering the ward every officer or person who was to touch a patient, his bed, or anything connected with him had to scrub his hands and nails with soap, water, and 1 to 200 solution of lysol at the bedside, to put on a gown reserved for that bed, and, having finished, to remove the gown and scrub again before leaving the bed. Under this régime secondary cases occurred as follows: Scarlet fever, two cases, due to a nurse; diphtheria, none; German measles, none; mumps, none; whooping-cough, five cases; chickenpox, eight cases; which facts the reporters regarded as tending to show that diphtheria, scarlet fever, and mumps are not air-borne, that measles and chickenpox are so in their early stages, but not after the third or fourth day, and that whooping-cough is probably so for an indefinite period.

As showing the very high degree of contagiousness of measles in its early stages it is well to cite instances from two official health bulletins. In Chicago thirteen children attended a birthday party, two of them having "colds." Next day both of these two had typical measles. After eleven to fourteen days every child of the party, except one who had had the disease within a year,

had measles. One of them developed a cold twelve days after the party, and she was taken from her convent school-room and put for a short time (an hour or less) in a large room with fourteen larger girls. Twelve days later all fourteen of those girls developed measles. Some of these then started epidemics and forty-seven cases were known to result from the first one. Aerial transmission of the contagion seemed very evident in the schoolroom, where contact could be ruled out.

A farmer and stockman from the little town of A. went to Kansas City with a carload of cattle. Nine days later he had a bad cold. He spent two days wandering from store to store in the little town telling his friends what a fearful thing his cold was. On the third day the eruption occurred and his physician tacked up a measles sign on the house. But it was too late. Two weeks later 28 of his friends who had listened sympathetically to his "cold" troubles also had measles. In two weeks more 28 other cases resulted, and two weeks later 30 cases — 86 in all. That, being nearly the entire population of the town, ended the epidemic in that community. But of the first crop of 28 cases at A. one visited the home of a physician in the city of B. The physician, not knowing his child was exposed, permitted its attendance at school regularly, and the child "broke out" in school. From this child it spread to 43 families, or 90 cases. A visitor from the city of C. in the town of A. came home, attended the city schools of C. and the disease spread to over 100 cases there. During the county examinations held in C., and at the height of the epidemic there, a pupil from the city schools of D. was exposed to the infection. In spite of this knowledge this pupil did not cease school attendance, and thirty cases resulted in D.

Carriers. Healthy persons may be carriers of and may convey diphtheria, cerebro-spinal meningitis, and infantile paralysis; while persons apparently recovered from them but still harboring the germs may convey the diseases just named, influenza, and scarlet fever.

Fomites. Fomites conveyance of infection is of course a form of mediate contact. It is more apt to occur the more recent the contact of the fomites with the sick person, as time, sunlight, drying, and other factors constantly tend to destroy the causative organisms unless these be on substances offering them food and favorable conditions, such as milk, meats, and other articles of human food. It is for this reason that terminal disinfection of houses after the occurrence of these diseases has of late been found to be much less important than it was formerly considered to be, with the result that it has been almost abandoned in several cities. Of the fomites the most dangerous are toys, handkerchiefs, and such other things as come into close contact with the patient, and especially such as are apt to be contaminated with the secretions from his nose, mouth, or other parts. It is often extremely difficult to draw hard and fast lines separating air-conveyance, dust- and droplet-infection, fomites-conveyance, and infection by direct contact. Where there has been a possibility of infection in one of these ways there have often been other opportunities for it.

Contact. Infection by direct contact we know to be possible in all these diseases, and kissing or sleeping with a person having any of them is particularly dangerous. They are dangerous cases to nurse or to treat, and nurses and doctors often contract them, and would do so much oftener except for the protecting influences of previous attacks, age, and constant sanitary precautions.

Sputum. The virus of most of these affections is given off in the spit and nasal secretions of persons suffering from them. Such is certainly the case in diphtheria,

scarlet fever, measles, mumps, whooping-cough, poliomyelitis, and sometimes in meningitis, and it may be true of all the others.

Other secretions. It is quite probable that the virus of some or all of these diseases may also be contained in other natural secretions of the patient, or in pus or eruptions that sometimes occur. It is highly probable that the ears may be infectious in measles, and discharges from the ears and nose are certainly so in scarlet fever. The virus of poliomyelitis has been demonstrated in the lining membrane of the stomach and bowels.

Skin. The eruption of smallpox consists at different periods of papules or pimples, vesicles or little blisters, and scabs. Both the vesicle contents and the scabs are known to contain the virus of the disease and are therefore to be avoided. While proof is lacking that the similar products of chickenpox and the scales or strips of skin shed after measles or scarlet fever are dangerous, it is the part of wisdom to avoid them also and to burn them as they are cast off.

Blood. In most or all of the diseases here considered the virus is at some time contained in the blood, and contact with that, as in dressing wounds or cleaning up spilled blood, would probably offer chances of infection.

Inoculation. The introduction of infectious matter into wounds serves to inoculate most of these affections. It is much resorted to in efforts to infect animals for experimental or other purposes, and in pre-vaccination times inoculation with smallpox was sometimes done as tending to produce a milder attack of the disease than resulted from natural infection.

Utensils. Infection through the medium of utensils, such as cups, spoons, thermometers, bedpans, or pipes,

may readily occur, but is an evidence of mediate contact rather than of contagion by virus contained in the air. Such articles can only rarely convey the disease in question, unless they have been soiled by contact with the mouth, skin, or other parts, or the secretions of a patient.

Animals. Animals may convey these diseases in various ways. They may gather up infected dust, sputum, or flakes of skin by lying on or near the sick-bed, and, by shaking themselves, liberate it elsewhere. It is possible that they might lick up moist sputum or other secretions, and retain the germs alive in their mouths and transmit them through fondling or fawning, even though they do not themselves have, or are not subject to, the disease. In other instances they are subject to the diseases, and may contract them through contact from eating spit, or in other ways, and breed and give off germs just as do human patients. Cats, dogs, and many other animals are subject to diphtheria, and may aid in spreading it. Cows suffer from a disease of the teats which, it has been said, can by means of milk set up scarlet fever in the human subject. Cattle suffer from smallpox in the mild and altered form known as vaccinia or cowpox, which, when in turn inoculated into man, affords protection against the first, or more severe disease. Whooping-cough has been transmitted to animals experimentally.

Milk. Epidemics of scarlet fever and diphtheria have many times been traced to contaminated milk, and it is not impossible that several of the other diseases we are discussing may likewise be so conveyed. The milk may, in exceptional instances and in the two diseases just named, be infected by the animal giving it, but the virus is usually if not always derived from some human

carrier of the organisms. Milk is a good culture medium for most disease-producing bacteria, and we have already seen how important it may be in the diffusion of typhoid fever and how readily it may be infected with the germs of that disease. It is therefore easily conceivable how milk-handlers suffering from influenza, mild diphtheria, mild scarlet fever, or others of the diseases we have been discussing, might, through coughing, tasting the milk, careless handling of vessels, or in other ways, introduce germs into it. Milk epidemics of scarlet fever, like those of typhoid, are apt to show a somewhat "explosive" character, that is, many cases develop at or near the same time. In Boston, Baltimore, and Chicago very large epidemics of septic sore-throat have been traced to infected milk. The following milk-borne epidemics of the diseases here considered have been investigated in Boston:

In 1907, 717 cases of scarlet fever from one milk-supply.
" " 72 " " diptheria " " " "
" 1910, 842 " " scarlet fever " " " "
" 1911, 1000 " " septic sore-throat " " "

Measles is not thought to be milk-borne.

Incubation periods. The virus of any disease having gained entrance to a susceptible body, some time is required for its multiplication and development, and for it to manifest its effects on the body. This time between the entrance of infection and the appearance of the first symptoms of disease is known as the incubation period, and is more or less constant for each disease. As it is important to take this into consideration in attempting to trace, control, or prevent epidemics, the following may be considered as representing it with tolerable accuracy in the diseases named:

Diseases	*Incubation periods*
Smallpox	8 to 20 days, oftenest 12.
Chickenpox	10 to 15 days.
Scarlet fever	1 to 7, oftenest 2 to 4 days.
Measles	7 to 18, usually 14 days.
German measles	14 days or more.
Mumps	14 to 21 days, usually 18.
Whooping-cough	7 to 10 days.
Influenza	1 to 4 days.
Diphtheria	1 to 7 days, usually 2.
Tonsillitis	1 to 3 or 4 days, usually 2.
Poliomyelitis	3 to 33 days, usually 8 or 9.

Degree and time of contagiousness. The incubation period is of value in enabling us to approximate the time and place of infection and to judge correctly of the length of time that suspects should be isolated. After the disease has developed, however, the character and length of the isolation period for the sick will be controlled rather by the degree of the contagiousness and the time at which it is greatest or during which it persists. It will therefore be well to summarize briefly our knowledge on those points.

Smallpox is one of the most contagious of diseases, and prior to the introduction of vaccination almost everybody had an attack, usually in childhood, as natural immunity is very rare. It is probably contagious from an early stage, and it continues so until the patient has recovered from the disease and has ceased to desquamate or shed scabs. As showing, however, that it is much more contagious in its early than in its late stages, may be cited the fact that the writer was able to infect monkeys with the vesicle contents gathered from early skin lesions, never with the scabs or late products of lesions from the same case. The monkey is, of course,

naturally much less susceptible to smallpox than is man. The same experiments seemed to indicate that for monkeys and in the Philippines the contagium is evanescent. However, it is reputed to be very persistent and to cling for long periods to infected places or things. *Varioloid* is a mild form of smallpox, usually seen only in persons who have been vaccinated. It may give rise to virulent forms of the disease if transmitted to more susceptible persons.

Chickenpox is probably air-borne from its onset and for three days thereafter.

Scarlet fever is contagious early, possibly more so when the fever is highest, and may continue so after the subsidence of all fever and for some weeks after the disease has apparently ended.

Measles is more contagious than smallpox or scarlet fever, but fortunately the period during which it is so is relatively short. The contagiousness is most marked during the period of onset and probably does not ordinarily last beyond the second or third day of the eruption. The virus is more evanescent than that of scarletina and neither places nor things retain it long.

The contagium of German measles is probably like that of measles, active for a short time, but not persistent.

Mumps is probably contagious for about nine days, as the virus has not been isolated from the saliva at a period later than that.

Whooping-cough is probably contagious during the entire period of its existence, including the early stage before the development of the whoop, although recent investigators have concluded that the contagious period rarely exceeds four weeks.

Influenza, likewise, is probably contagious from the

onset. It often passes into a chronic stage, wherein the active symptoms have subsided, but a slight cough or some similar reminder persists. As the bacilli remain and may be expelled by the cough, there is reason to think that such cases may remain sources of infection for indefinite periods although, as stated, the causative relationship of this bacillus is not now admitted by all.

Cerebro-spinal meningitis being due to an organism that may be found in healthy noses and throats, but one which possesses only feeble resisting powers, it is impossible to say how long it may be contagious. The degree of contagiousness is not high. Extensive work aimed at the control of this disease in cantonments by examination of many thousands of men for the purpose of detecting carriers and subsequent treatment of those carriers, work done in training camps in 1918, is not thought to have given results at all commensurate with the work, and the English conclusion that reducing crowding was the most efficient measure of control is considered sound.

The organism of *infantile paralysis* may also be found in the healthy nose and throat, but the contagiousness of that disease is likewise not high.

Diphtheria is contagious from its onset until such time as the bacilli have disappeared from the breathing passages, a period exceeding the apparent duration of the disease by days, weeks, or months. Different strains of the organisms present decided differences of virulence, and this partly accounts for the varying grades of severity shown by epidemics. The virus attaches itself to the clothing, the bedding, and the room in which the patient has lived, and has in many instances displayed great tenacity.

Tonsillitis is an inflammation of the tonsils due to any cause. It may, therefore, be diphtheritic, but as generally used and as intended here, the term signifies a tonsillar inflammation due to other organisms than that of diphtheria, and applies to the common "sore-throat" of winter-time. Though neither so dangerous nor so highly contagious as diphtheria, it occasions much discomfort and may spread through a barrack to a considerable extent, especially if there be overcrowding. *Septic sore-throat* due to milk has been discussed. It differs from ordinary tonsillitis in its greater severity and its greater tendency to spread to other structures and to infect the blood-stream and the lymphatics.

PREVENTION AND CONTROL

The measures of control are general and special. The former include all such measures of hygiene, cleanliness, housing, heating, clothing, and so forth as tend to lessen the dangers of crowding, contact with the sick, poor ventilation, and bodily depression.

General measures. *Ventilation* should at all times be abundant, and it should be superabundant in the neighborhood of the sick, as it not only promotes comfort and health, but dilutes the poison or contagium, and so reduces the dose of it that those in the neighborhood may inhale.

Of even greater importance than ventilation is the avoidance of crowding, the wide separation of beds, and the lessening of contact. Beds in barracks should be at least three feet apart, and preferably six. Separation of beds by partitions or screens is highly desirable.

Water is of only minor importance in the diffusion of these diseases, but the supply should be good and

special care should be used in disposing of that which has been used in washing the sick or their effects. It should be disinfected by chemicals or heat.

The *common drinking-cup* is a source of danger in barracks or in camp, and should be abolished in favor of individual cups or of bubbling fountains that cannot be contaminated by ordinary usage in drinking.

Foods, other than milk, are seldom responsible for the spread of the diseases considered; but food that has been in contact with the sick should be carefully disposed of. The diphtheria bacillus, for instance, might grow on meat, bread, potatoes, or other food-articles.

Persons having any of these diseases should be excluded from kitchens, dining-rooms, and all contact with any food except that for their own use and consumption. Supplies from bakeries, meat-shops, or other food-distributing places that harbor persons sick of these diseases, are best avoided. It is conceivable that they may occasionally be transmitted by means of food that has been exposed for sale in places where it might be contaminated by infected dust or by droplets of spit expelled by coughing persons.

Milk is particularly dangerous as a means of dissemination of scarlet fever, sore-throat, and diphtheria, and it may possibly act in a similar capacity for others of these diseases. It is certainly the part of wisdom to exclude persons having, or recovering from, or in contact with, any of these diseases, from handling milk intended for the use of others. In case of epidemic the milk-supply should be investigated, and steps be taken to prevent infection through it. Pasteurization or boiling will make the milk safe if it is protected from subsequent contamination.

Vermin should be guarded against as possible disseminators, as in measles, scarlet fever, smallpox, and occasionally some of the other diseases considered, the circulating blood may be found infective. Smallpox has been attributed to flea transmission, though the evidence has not been such as to cause the acceptance of the idea by many. Still, it is not at all impossible that this disease may at some time be found to be insect-borne. Biting flies are also said to carry infantile paralysis, and the hypothesis is entitled to respect because of the support found for it in experiments at Harvard and in the epidemiological studies published by the Massachusetts State Board of Health.

It is obvious that *house-flies* might become polluted from eating or walking over infective excretions and convey the germs to other persons or to food-articles.

Animals, such as dogs, cats, and other pets, should be excluded from access to the sick for reasons already set forth.

Of special measures of protection against these diseases the following are probably most important:

Early diagnosis. Early diagnosis is absolutely essential for the control of most of them, and is helpful in all. Measles is highly contagious before the eruption appears and may be widely spread by persons apparently suffering from "colds." All suspicious cases should therefore be reported to the surgeon for examination as soon as any symptoms present themselves. As stated before, company officers should encourage their men to go on sick report at the first appearance of disease.

Persons in contact with diphtheria should be examined to see if they are carrying the germ in their throats or noses.

Notification. Notification of cases is the next step in control. It follows diagnosis naturally in the case of soldiers reporting to the surgeon; but occasionally officers or their families, or more rarely enlisted men, consult civilian physicians. In such instances the presence of contagious disease may not be notified and may escape official recognition, with the consequence that preventive measures may not be adopted. Line officers, enlisted men, and civilian physicians, all should realize that the highest function of the medical officer is the prevention of disease, and that they are preventing his performance of it, as well as violating orders, when they do not promptly report to him any cases of contagious disease in the post with which they may be concerned. Unless agreeing to act thus fairly, civilian physicians should not be allowed to practice on a military reservation, and they cannot properly do so; and officers and men who through carelessness or design are responsible for the presence of such diseases on the post being unknown, should be punished.

Tracing cases. Notification of the presence of any of the diseases in this group should at once lead to an investigation of its source, with the object of removing this if possible. The nature of the investigation will be indicated by what has been said as to methods of infection and incubation periods.

Isolation. The sick should be isolated as soon as the diagnosis is made or suspected. The character and duration of the isolation will vary with the disease. It should in all cases be sufficiently strict to prevent all unnecessary contact with the sick, and should last until the dangerous period is safely past.

There can now be little doubt that much of the bene-

fit that results from isolation is due to lessened opportunities for contact with the patient or his secretions. Much therefore depends on having the nurse isolated also, or having him so thoroughly drilled in freeing his person from the germs and in avoiding contact with them as to reduce the chances of mediate contact through him to a minimum.

Smallpox should be isolated at some distance from dwelling or gathering places, even at the expense of some inconvenience. In military life tents make suitable isolation hospitals unless the weather is unusually severe. The possibility of apparently well persons acting as carriers must be borne in mind. Diphtheria patients and their attendants must not be released from isolation until their respiratory passages are free from germs, scarler fever patients until all discharges from the throat, nose, and ears have ceased, and the individual has been well a month or more. In all instances the character and duration of isolation are matters to be determined by the medical officer. Men breaking isolation bounds should be severely punished, as they may expose their comrades to grave danger. Persons known to be exposed to these diseases may properly be isolated, or at least kept under strict surveillance, for a time equal to the maximum period of incubation. Those suspected of having any of them should be isolated until the diagnosis is definitely established in the negative.

Disinfection. Everything that has been contaminated by the use, association, or proximity of the sick should be indisfected before being allowed to pass again to its ordinary place.

The *sick person* and his *attendants* should be well bathed before coming out of isolation, and the bath

should be followed in the case of smallpox, scarlet fever, or diphtheria by a washing with an antiseptic solution. Clean clothing should then be put on. *Animals* that have been in the sick-room should be similarly treated. *Clothing* and *bedding* may be disinfected by boiling, steaming, soaking in an antiseptic solution, or with formalin. The last named method is less reliable than the others. *Houses*, and especially the *room* occupied by the sick person, and its furniture, should be scrubbed, sunned, and aired. The belief that fumigation and other house disinfection is unnecessary is growing, and experience based on the belief indicates that those measures may usually be ignored with safety. Sunlight, cleanliness, time, drying, and fresh air do the work. *Utensils* may be boiled, steamed, or washed in antiseptics, while letters, books, and similar articles may be sterilized with formalin if they have been in contact with the patient. The *discharges* of the patient should be mixed with formalin or carbolic solution and allowed to stand an hour before being thrown out. The *sputum* should receive particular care, as it carries the contagium of most if not all of these diseases. The patient should only spit into vessels containing antiseptic solution, and even then it is safer if the spit be burned. Handkerchiefs and cloths used to wipe the mouth or nose should be burned or boiled. The use of paper handkerchiefs by all sick persons would be a wise and useful measure. Surgical dressings should be burned.

Induced immunity. The most efficient measure for the prevention of *smallpox* is the induction of acquired immunity through *vaccination*. The government very properly demands that every recruit shall be vaccinated, but occasionally the inoculation does not "take" on a

susceptible man, and through a combination of circumstances he may escape its repetition. In civil life there is a considerable agitation against the use of vaccination, the agitators alleging that it does not protect against smallpox, that it is an invasion of personal rights, and indulging in several other incorrect statements. It is not purposed to discuss the matter at length here, but it may be stated that the evidence that vaccination does protect against smallpox is overwhelming, and a belief to the contrary, however honest and earnest it may be, cannot justify any one in endangering the efficiency and safety of an army by its neglect, any more than can a belief that every man is born with a right to smallpox if he wants it. Any officer or man who in any way interferes with the complete and thorough vaccination of the army makes a great mistake and commits a grave offense.

The spread of *diphtheria* may be partly controlled by the use of *antitoxin*. This may be and is very generally used in the treatment of those sick with the disease, but it is also of value when used as a preventive measure. It is then injected in relatively small doses into persons brought into contact with the disease. So used it greatly lessens the liability to infection, and to severity in case infection does occur. However, because of the possibility of rendering the individual susceptible to anaphylaxis in case of necessity for using the serum at a much later date, it is preferable to prevent diphtheria by other means, if possible. It is now possible to determine, by means of the introduction of a small amount of diphtheria toxin into a slight abrasion of the skin and examination of the irritation resulting, a test known as the Schick test, what individuals have

enough antitoxin in their own blood to protect them from diphtheria. Those individuals need have little fear of diphtheria, as their immunity is usually lifelong, while those in whom much irritation is caused should use the greatest care in avoiding exposure to it, as their susceptibility to it is usually lifelong. It is probable, though, that there are other factors concerned in immunity to diphtheria, as the writer, for example, gives a Schick reaction such as should indicate a great susceptibility to diphtheria, yet he has never had the disease, despite many exposures to it. All of his children give similar reactions and but one has had the disease, and then very mildly. Vaccinations and the use of preventive injections of antitoxin have not yet proved of value in protecting from the other members of this group, though they may later be found applicable in some instances.

CHAPTER XIV

INSECT-BORNE DISEASES

The principal human diseases now known to be insect-borne are malaria, yellow fever, filariasis, and dengue, carried by mosquitoes; sleeping sickness, carried by tsetse flies; plague, carried by fleas; spotted fever in Montana and the relapsing fever of central Africa, carried by ticks; typhus fever and relapsing fever of most parts of the world and trench fever, carried by lice; river fever or tsutsugamushi disease of Japan carried by a small red mite; sand-fly fever or three-day fever of the Balkans and other parts, carried by sand-flies; Chagas' disease in Brazil, carried by the "barbiero," *Lamus megistus;* and kala-azar, which is almost certainly insect-borne, though it is not yet quite determined what insect is the carrier, the bedbug being accused in India and the flea in the Mediterranean countries. Leprosy, smallpox, poliomyelitis, pellagra, and a number of other human diseases have been attributed by various writers to insect carriage, but the proof adduced has not been such as to carry conviction to the majority of workers. Very many diseases of animals are insect-borne, among them some of the most widely spreading and fatal. Both animals and man are subject to infestation with the larvæ of flies that deposit their eggs on the mucous membranes, under the skin, or in wounds of their hosts. The screw worm is an example of this.

The diseases named above will be considered in groups made to conform to the insects carrying them.

MOSQUITO-BORNE DISEASES

Malaria. The most widespread and common of these is malaria. It prevails in most tropical and sub-tropical countries, and in some of them it produces a great mortality, while it causes much suffering, weakness, and loss of time, even where it is less fatal. It is an important cause of sickness in our army in many parts of our own country, as well as in Cuba, Porto Rico, the Philippines, and the Isthmus of Panama.

Since the beginning of the Spanish-American War the knowledge of the methods of control of this disease has increased so rapidly that it has now become possible for us to make healthy communities out of places formerly notorious for the certainty and speed with which newcomers sickened or died from malaria, though it must be admitted that the accomplishment of such a result is both difficult and expensive.

As stated in a previous chapter, there are at least three varieties of this disease which differ because the parasites causing them do so, and which manifest themselves in paroxysms of chill, fever, and sweat, that come at twenty-four, forty-eight, or seventy-two-hour intervals. This regularity of manifestation is only shown, however, in cases of uncomplicated single infections. Owing to multiple infections or complicating circumstances, any one of these types of malaria may show extreme irregularity and may be mistaken for other diseases, the diagnosis being made possible only by examination of the blood, and, at times, with great difficulty. The fever may be continuous and the general symptoms such as to make the disease appear much like typhoid. Or it may be manifested as a neuralgia, as a sudden

attack resembling apoplexy, as anæmia, or in other obscure ways. This disease also exhibits periods of latency, during which the parasite is present in the body, but in such numbers or under such control by the body forces, that no signs or symptoms are present. When, however, the vital forces are reduced, as by exposure, overwork, alcoholism, or other disease, the parasites gain the ascendency and the disease may manifest itself in a severe manner. Many natives of highly malarious regions may be partly immune and show no symptoms even when harboring very severe infections.

Whatever the character of its manifestation, however, the infection is always received through the bite of a mosquito. Officers from time to time express views to the contrary, usually basing them on their own faulty observations. Occasionally there is reason to suspect that the views are exploited to account for the presence of malaria when the efforts to prevent mosquito-transmission entail an inconvenient amount of trouble. The fact is that malaria has been investigated with a thoroughness that has been accorded to few other diseases, and the method of mosquito-transmission has been abundantly proved, and no other appears even probable. "If, after they have imbibed malarial blood, certain species of mosquitoes be dissected at serial intervals, the evolution of the malaria parasite can be followed in their tissues, until, finally, the germs of the parasite can be tracked into the cells and secretions of the salivary glands of the insect.

If after a week, or thereabouts, a similarly fed mosquito bites a hitherto uninfected man, in many instances, after a few days, that man will exhibit the clinical phenomena of malaria infection and the characteristic parasite in his blood.

A non-immune, if effectually protected against mosquito bite, will not contract malarial disease, however long he may live in highly malarious localities.

Most observers are now of the opinion that the malaria parasite, under natural conditions, can be acquired by man only through the bite of the mosquito; that the mosquito can acquire the parasite only by ingesting the blood of a malaria-infected man, or possibly other mammal; that there is no extra-corporeal life other than that described; that there is no authentic instance of malaria being acquired in uninhabited places; that in the case of malaria in connection with soil disturbances, it depends on the creation during digging operation of puddles of water in which mosquitoes breed; and that its epidemic occurrence under these circumstances is owing to unhygienic conditions such as usually prevail when large bodies of men, some of whom may bring the infection with them, are brought together on public works attended with extensive earth-cutting, as in railway, road, or canal-making.

The malarial mosquito. Several species of mosquitoes are capable of transmitting the disease, but they all, so far as now known, belong to the sub-family *Anophelinæ*. The features by means of which these various species may be identified cannot be discussed here, and positive identification is a labor necessitating some time and effort even on the part of the specialist; but a popular rough method of identifying anopheline mosquitoes in general is that the adults, when at rest, stand with their bodies almost or quite at a right angle with the surface on which they are resting, while commoner species rest with the body more nearly parallel to the supporting surface. The larvæ, or "wigglers," of the former class, on the other hand, rest with their bodies like floating sticks, parallel to the surface of the water in which they are swimming. The more common varieties have theirs more nearly at a right angle to it. These mosquitoes bite principally at night.

Yellow fever. Yellow fever is an acute and very fatal disease that occurs principally in tropical and subtropical America, though epidemics also occur on the west coast of Africa, where the disease was possibly introduced by slave-traders. It has appeared in epidemic form as far north as Philadelphia.

Method of transmission. Until after the American occupation of Cuba and the subsequent work of the board of army medical officers, under the presidency of Major Walter Reed, the method of infection was unknown, and water, contact, fomites, poor police, and atmospheric conditions were all credited as means. That Board cleaned up all obscure questions as to the manner of transmission, and established beyond dispute the fact that yellow fever is transmitted by the bite of infected mosquitoes of the species *Stegomyia fasciata.*[1] It cannot be transmitted by water, food, fomites, air, or contact, nor is its spread influenced by poor policing, except as the latter promotes the breeding of mosquitoes. The beautiful reasoning and experiments which served to establish our knowledge of the means of transmission also cleared up many hitherto obscure points about the disease, and, better still, led to the use of anti-mosquito measures that resulted in its eradication from Havana, and later from New Orleans, the Canal Zone, and other regions. This constituted one of the greatest sanitary advances that the world has ever seen, one making possible the rejuvenation of Cuba, the construction of the Panama Canal, and, it is hoped, the civilization and development of all tropical America; and it is well that army officers should keep in mind that all of these things were made possible by the fact

[1] Since known as *Stegomyia calopus* and as *Ædes calopus.*

that there happened to be in command, in Havana, a line officer who had a knowledge and an appreciation of the importance of military hygiene.

Natural history of the disease. The Board of which Major Reed was the head showed that contact, fecal contamination, handling of fomites, breathing the close air breathed by yellow-fever patients in poorly ventilated places, and all such things, were incapable of transmitting the disease, but that the bite of some infected mosquitoes would be followed by the fever in from three to five days, or occasionally longer. This is the ordinary incubation-period in man, and accounts for the fact that non-immunes may develop the disease so short a time after arrival in places where the disease prevails. But there is also an incubation-period in the mosquito, as shown by the fact that it cannot transmit the disease until twelve days after it has imbibed the infection with the blood of a sick person. This accounts for the half-month elapsing between the arrival in an uninfected place of a case of yellow fever and the appearance of the first case of the subsequent epidemic. This double incubation period, three days for a case in an already infected district, and fifteen or more days for secondary cases in previously non-infected districts, is thus clearly explained.

Not nearly all mosquitoes biting yellow-fever patients are capable of transmitting the disease even after twelve days, and the Board showed that this was because of the short period during which the yellow-fever patient is infectious. Unless it bites him during his first three days of sickness, the insect obtains no infection and can transmit none. It was also demonstrated that the cause of the disease is in the blood, that it passes through very

fine filters, and is probably too small to be seen with our microscopes, and that it may persist in infected mosquitoes for weeks or months.

These experiments fully explain: 1st, the impunity with which a yellow-fever patient can be visited by a non-immune if outside the endemic area: the mosquitoes in the vicinity are not infective. 2d, the danger of visiting the endemic area, especially at night: the mosquitoes there are infective and active. 3d, the discrepancy between the incubation-period, three to five days, of the disease, and the incubation-period, fifteen days and over, of an epidemic: the necessary evolution of the germ in the mosquitoes infected by the original introducing patient demanding the space of time indicated by the difference between these two periods. 4th, the clinging of yellow-fever infection to ships, buildings, and localities: the persistence of the germ in infected mosquitoes which are known to be capable of surviving for five months, and probably longer, after feeding on blood. 5th, the high atmospheric temperature required for epidemic extension of yellow fever: such temperature favors the activities and propagation of the mosquito, and is probably necessary for the evolution of the germ also in the mosquito.

The yellow-fever mosquito. The mosquito that transmits yellow fever is a very common one in all those parts of America that show the disease. A closely allied or identical species is abundant in the Philippine Islands. Whether or not this Philippine variety is capable of transmitting the disease is not positively known, but if it can do so the introduction of the disease into those islands, a thing quite possible after the opening of the Panama Canal, might prove a disaster of the first magnitude and a great addition to their already numerous afflictions. However, yellow fever is so thoroughly under control in Panama and other points from which ships are apt to go to the East, and the method of its control

is so well understood and the journey so long, that the chances of such introduction are considered remote.

The mosquito concerned is a small black one, with white or silvery lines and bands on the thorax and legs. There is a peculiar lyre-shaped figure on the back of the thorax which, together with the white bands on its legs, makes a rough diagnosis of species possible. The insects particularly prefer low-lying shores, but may be found in other places. They are essentially house-lovers, are active biters, silent and very quick, so that they are harder to catch than other varieties. They breed in small artificial collections of water, such as barrels, puddles, cisterns, and partially filled tin cans. "The nature of the water appears to be a matter of indifference: it is found equally in rain or waste water, but more frequently in water discolored by decaying vegetable matter."

Dengue. Dengue is a disease of very low fatality, but one which may occasion much suffering and anxiety, and which sometimes occurs in widespread epidemics. The disease causes, on an average, about one week of absence from duty, and if the epidemic involves thirty or forty per cent of a command, a not unusual figure, the strength of the force will be much impaired. It prevails in the West Indies, the Philippines, our Southern States, and in most other parts of the tropical and subtropical world. Like yellow fever, it is a disease of hot weather and low lands, that has prevailed as far north as Philadelphia in summer-time. It is transmitted by a very common variety of mosquito, *Culex fatigans*, and possibly by other varieties, but not by contact, food, drink, air, or fomites. The incubation-period is from three to seven days, usually about four;

the causative organism is contained in the blood, passes through fine filters, and is probably too small to be seen with the microscope. The disease resembles yellow fever in many respects, and has often been confused with it in America.

Filariasis is infestation with any one of several varieties of filaria, or hair-worm, whose young circulate in the blood. It is thought to be related to elephantiasis, but was sufficiently discussed in a preceding chapter. The parasites are introduced through the bites of mosquitoes, one of the most common and widespread species, *Culex fatigans*, acting as a carrier for at least two varieties. The insect bites both by day and by night.

Anti-mosquito measures. The prevention of these mosquito-borne diseases rests entirely upon our ability to protect against the bites of infected insects, except in the case of malaria, in which we can derive aid from the administration of quinine. Our success then depends on anti-mosquito measures, and it is necessary to discuss these briefly. Mosquitoes breed only in water, the young being as much dependent on that fluid as are fish or tadpoles. The *Culex*, or common mosquito, which transmits dengue and filaria, and the *Stegomyia*, or striped mosquito, which carries yellow fever, generally breed in vessels of water, cisterns, or drains. The *Anopheles*, or malarial mosquitoes, breed "mostly in shallow puddles on the ground, in small ponds, in slow and small runnels of water, in pools of rain water, on rocks, on the margin of slow-running streams, and sometimes, but rarely, in vessels of water."

It must be borne in mind, though, that the *Stegomyia* is really the only one of the mosquitoes known to

carry disease that is so fixed in its habits as to make its extermination relatively easy. This mosquito is practically banished from the Canal Zone, though still found in the adjacent city of Panama, and in the Zone very little work is required to keep free from it. The work against *Culex* and *Anopheles*, however, is constant, hard, expensive, almost endless, and distinctly less successful in its results. These mosquitoes, as represented by their various species, can manage to find favorable conditions in the Canal Zone at all times of the year, and in almost all kinds of water, including a mixture that contains a large amount of sea-water. In fact, the largest and most annoying flights of mosquitoes seen on the Zone have always come from the hydraulic filling of fresh water swamps with salt water material, that is, with mud pumped from under salt water. At Gatun, Toro Point, Cristobal, Panama, and other places this has been the case.

The larvæ or wigglers of all kinds of mosquitoes require at least six or seven days of life in water before they can develop into winged insects, and the time is usually longer, especially if the weather be cool or conditions otherwise unfavorable. Drying kills them and also destroys mosquito eggs. On the other hand, natural degrees of heat and cold do not necessarily destroy them if they remain in water, and in northern latitudes both larvæ and adults may survive several freezings during a winter and again become active when warm weather returns. Usually only female mosquitoes suck blood, and they do so because the rich nutriment hastens the ripening of their eggs, and these are generally deposited only after such a meal. As the mosquito fills herself to a degree that greatly increases her bulk and weight,

and makes flight laborious and slow, she usually seeks a place near at hand in which to deposit her eggs. Partly for this reason it follows that most infested houses or localities breed their own mosquitoes.

It has been demonstrated in the Canal Zone that *Anopheles* can and on occasion do fly more than a mile from their place of breeding. The occasions for such flights are, in the writer's opinion, limited to such as present the following circumstances: a large area where the conditions for breeding are unusually favorable, such as one of the salt hydraulic fills mentioned above, an enormous amount of breeding in such an area, lack of abundant human blood for food in the neighborhood of the breeding place, the presence of abundance of food (a town) at a distance of a mile. Were there another town within two hundred yards, or a quarter or a half of a mile, the chances are that the town a mile away would scarcely notice any change in the number of mosquitoes. In fact, such has been the experience at several places on the Isthmus. The conditions favored a big flight, but a human barrier in the neighborhood served to check it and to make the increase of mosquitoes a merely local one. In ordinary sanitary practice, and not considering such exceptionally large and favorable breeding places, the control of all breeding within four hundred yards of towns, posts, and houses serves to make them fairly comfortable and safe places of residence. But even this much is no small task in the tropics. The *Anopheles*, like the *Stegomyia*, appears to be a man-lover, though, unlike it, not a house breeder. Practically always breeding in the open, in what might be considered natural, though often actually artificial, collections of water, and almost never in cans, barrels, cisterns, and like containers, it is

nevertheless usually found fairly close to human habitations; and many localities in the Canal Zone that formerly, when towns were near, bred great numbers of *Anopheles*, now, since the areas in question have been depopulated, breed almost none. "Mosquitoes, especially *Anopheles*, love thick undergrowth."

Destruction of breeding-places. The facts above stated indicate the steps to be taken in warring against them, and of these, destruction of breeding-places in or near camps, habitations, towns, and garrisons is probably the most important. The measures designed to attain this end are numerous. *Drainage* by ditches or by subsoil tile, *reclamation* of swamp lands, *opening* fresh water or brackish swamps to salt water tides so as to convert them to salt water marshes and flood them daily with strong sea water, the *filling* of pools, puddles, hollows, and marshes, the *building* of dikes and embankments to create *lakes* instead of marshes and to protect dry lands from flooding, the clearing of the banks of lakes and streams from brush and grass and cutting them steep and deep so as to permit and favor *wave action*, the *cleaning*, *straightening*, and *narrowing* of streams to give them a more rapid flow, are some of the general measures that can be profitably employed in the vicinity of towns or of permanent garrisons. Each of these measures may be very expensive as to first cost, yet each may prove a highly profitable investment. A few specific instances may be cited from the Canal Zone. Drainage by ditch and tile has been used in and about every town in the Zone, and has always given good results and done away with breeding places. Opening fresh water swamps to tidal wash has done away with large areas of breeding at Mindi Island near Cristo-

bal. The filling of swamps and low lands, often done as a mere matter of convenient disposal of soil, has made dry many former breeding places. Even the hydraulic fills that have been mentioned as giving rise to excessive breeding, only do so for a period of months, and after they have dried out they may leave fine sites for town extension, as at Ancon and Balboa. The building of dikes and the creation of lakes have done good by deepening the water, as mosquitoes rarely breed in water more than two or three feet deep, and by creating more favorable conditions for fish and for wave motion, both of which destroy larvæ. A small lake at Pedro Miguel, which long produced large numbers of mosquitoes and caused the expenditure of much money and labor on its treatment, was rendered harmless and self-caring by the expedient of cutting its banks at an angle of one on one and a half to a depth of a foot and a half above and the same below its general level, and freeing them of vegetation. This allowed the small fish and the wave action to get at and destroy the larvæ that formerly found shelter from both in the vegetation growing in shallow water along shore. The clearing and straightening of streams, "training" them to run rapidly and strongly and to flush themselves well, act similarly. Cleaning bodies of water of vegetation is at times a most useful expedient, as mosquitoes breed in water-holding leaves, such as those of the water "cabbage" and the water hyacinth, while other vegetation, such as Para grass and algæ, offer shelter wherein the larvæ find protection from fish.

But efforts must not be confined to such large undertakings, because the chances are that less ambitious projects, carried out in or about the dwelling, may accom-

plish almost as much good, and it will be manifested more promptly. Such local measures will include the filling of small hollows in the yard or about the house, or cutting such outlets from them that they will empty quickly after rains, filling or preventing the formation of pockets or pools at the outlets of drains or under faucets, filling, emptying, or obliterating hoof-tracks, wagon-ruts, and similar small depressions, seeing that fire-buckets, fountains, drip-pans under ice-chests and similar water containers are emptied twice a week, and all larvæ contained in them killed. Empty or partly empty bottles, boxes, tin cans, tubs, and flower-pots must be removed or placed in such positions or conditions that they will not catch and hold water. Useless joints or sections of bamboo must be removed, and pieces that are in use or that form parts of buildings should, if open, be bored at the lowest level of the joint so as to let all water run out. The water in tins or saucers under table-legs or elsewhere as a protection from ants should be kept clean and free from larvæ. It would be well to have such things filled with antiseptic solution rather than plain water. Sagging eave-troughs and drain-pipes and catch-basins that do not empty promptly, may afford breeding-places, and should therefore be made right. Banana plants afford quite sufficiently large receptacles for breeding water at the points where the leaves diverge from the main stalk, and trees may provide them in knot-holes. It may be stated, however, that breeding in banana plants is less common than is generally thought. All such places must be investigated and faults corrected. Irrigating ditches should run freely and with a good current when in use, and should drain dry at other times. They should not present stagnant pools at any

time. Thick underbrush and high grass should be cut and cleared away, as it not only shelters and harbors the grown mosquitoes, but hides and preserves small collections of water and keeps them from drying. Cisterns, shallow wells, rain-barrels, and other large useful containers of water should be screened or tightly covered so that mosquitoes cannot gain access to them. Privies and cesspools should likewise be protected by netting or tight covers, so as to keep them free from the insects, and drain outlets should empty on smooth rocks, or be otherwise so arranged that pools and puddles are not formed by their discharge. Other precautions may be necessary and the circumstances may suggest them. The object to be kept in mind is the doing away with all stagnant water.

Destruction of larvæ. Many of the measures outlined above, such as draining pools and emptying fire-buckets, are destructive of larvæ in that they allow these to dry. In some instances, however, it is not possible to do those things, and other methods of destroying larvæ must be resorted to. Mosquito larvæ, like all other living creatures, have their natural enemies, and these may be utilized. Many varieties of small *fish* devour them, and some of these, for instance the "millions" of Barbados, are said to do the work so thoroughly as to quite prevent mosquito development in ponds stocked with them. Many varieties of fish are useful for this purpose, and ponds, streams, and marshes that create mosquito nuisances can be profitably stocked with them. Other water animals, such as tadpoles and some kinds of beetles, are also reported to be destructive of larvæ. The larvæ of dragon flies are certainly so, but as regards the tadpoles and beetles the

writer cannot speak from personal knowledge. Ducks, especially mallards, are said to be very destructive to mosquito larvæ.

Moulds and other germs may also attack the larvæ and cause their death through disease. Such factors often make the task of artificially rearing mosquitoes for experimental work one of some difficulty, but, so far as known, they have not been used to reduce their natural occurrence. That the natural enemies are not alone sufficient to destroy all larvæ is evident from the fact that the latter are occasionally numerous in waters abounding with fish and tadpoles.

Chemical poisons may also be used, but they are dangerous and can only be applied to waters which are not needed and which should, therefore, be drained away or otherwise disposed of.

Very extensive use has been made in the Canal Zone of a preparation known as *larvacide*. It has been of very great value in many places, but is not now used so extensively as formerly because the cost of it has increased so greatly. It is made as follows: Crude carbolic acid of a specific gravity not above 0.97 and containing fifteen per cent of tar acids is heated. Into 150 gallons of this 200 pounds of crushed and sifted common rosin are stirred, and then 30 pounds of caustic soda dissolved in six gallons of water. These amounts yield three and a half barrels of larvacide, which for use is diluted with four or more parts of water. It kills mosquito larvæ in five minutes in a dilution of 1 to 5000.

Oil, preferably *crude petroleum*, is much used as a means of destroying larvæ. It acts mechanically. The larvæ, though living in water, are air-breathers, and must come to the surface at intervals of a minute or so

for that purpose. They breathe through a small pipe or tube which rises above the back near the tail, and which is projected from the surface of the water when air is to be taken in. If the water be covered with a film of oil, this little tube becomes clogged with the latter as it passes through it, and respiration is hindered or prevented so that the wiggler dies of suffocation. Other oils will answer as well, but crude petroleum, because of its cheapness, harmlessness in the amounts used, and its slow evaporation, is preferred. Refined kerosene spreads more rapidly and evenly, but it also evaporates more readily. Some crude petroleums, especially such as contain a considerable asphalt base, as do California oils, will not spread well if applied to water without any diluent. They are likewise too thick to be pumped readily with small (knapsack) pumps or to drop reliably from drip cans or barrels. It has therefore been the practice in the Canal Zone to "cut" this heavy oil with larvacide or kerosene, of which enough is added and mixed in to overcome the faults mentioned. The amount of either required will vary from two to twenty per cent, both amount and choice of diluent being determined by circumstances. At the present writing larvacide costs two and a half times as much as kerosene, and the latter is therefore ordinarily preferred as a diluent of crude oil, though special circumstances make the former preferable occasionally. The oil may be applied by sprinkling, spraying, or "painting" it over the surface. In the last-named method it is applied by means of a saturated rag on a pole that is rubbed or brushed about on top of the water. So long as the surface is well covered the method of application does not matter. The applications should be renewed as necessary, and the frequency of this will

depend on several factors that must be taken into consideration. A slight current or a prevailing wind may drive all of the oil to one side of a pond or may remove it in a short time. In such cases the renewal must be more frequent, and must be on the side from which the oil flows. Light oils, of course, require more frequent renewal than the heavier ones that do not evaporate so readily. The surface of the water should not be left uncovered for more than three or four days. Recent experiments in mosquito destruction in Arkansas rice-fields showed very satisfactory distribution of oil to such fields from the "broadcasting" of oil-saturated sawdust. One bushel of sawdust was saturated with three gallons of crude oil and twenty-six gallons thus applied to the acre of flooded field. For oiling running streams, small springs, drainage ditches, and similar water runs, use may profitably be made of drip cans or barrels. These may be made from oil barrels, cans, or other receptacles. There are many ways of arranging the drip, and the officer or man in charge can devise one readily. A spigot may be used, or a hole made in the receptacle may be stopped with a plug having a small groove cut in one side, or with one having a larger groove filled with wicking or cotton waste, the idea being to have a drop fall often enough to keep the water covered with a thin coat of oil. In order to make the drop break and spread when it strikes the water the receptacle should be raised two or three feet above the water level. Small wet places caused by a seepage of water from a hillside or elsewhere may be easily and profitably oiled by pegging down at the upper edges of the seepage area small bundles (a handful) of cotton waste saturated with oil. These should be renewed about once in two weeks, as by that

time they are apt to be hard and to give off an insufficient amount of oil. Another useful, simple, and successful measure of treating such seepage areas is to concentrate the moisture into tiles or ditches and then oil it if necessary.

If water be drawn off through a pipe running well under the surface, oiling does not injure it for household uses and is therefore applicable to cisterns, rain-barrels, and other domestic supplies.

Small collections of larvæ-containing water can be easily emptied by sweeping or other means, and the larvæ promptly die. It is said that the common prickly pear cactus of the tropics can also be used in destroying larvæ. "The thick, fleshy leaves contain a mucilage which exudes when the leaves are chopped and added to water, the mucilage rising to the surface and forming a practically air-tight covering similar to that formed by oil."

Destruction of adults. Under ideal conditions mosquitoes should not reach adult life where an active anti-mosquito campaign is being carried on. Under possible conditions some are almost certain to do so, and under the best conditions obtainable at a reasonable cost a good many are apt to be found. It often happens too that a camp is to be maintained at a place for so short a time, or a given piece of construction work is so small and so unfavorably located, as to make adequate measures against breeding and larvæ far too expensive in money and labor to be practicable or worth while. In such circumstances the destruction of adult mosquitoes may be the only available means of getting rid of them. The method is especially applicable in ridding houses of mosquitoes that have bitten yellow fever patients.

The house may be closed and sealed and then fumigated with sulphur, the vapor of a mixture of camphor and carbolic, or with the fumes of pyrethrum. The first two kill the mosquitoes, but the pyrethrum may only stupefy them, so it is necessary to gather them up and burn them. As an antimalarial measure, fumigation, because it cannot be continued daily and because of the cumbersomeness of the process, is of less value than hand catching, which may take the form of "swatting" or may be better accomplished by the use of a tube or wide-mouthed bottle containing a chloroform-saturated pad. This is best prepared by taking a neckless vial one inch in diameter and five or six inches deep, filling it for an inch with cut rubber bands, and placing over these a disk of blotting paper. Then pour in one or two teaspoonfuls of chloroform and allow it to be taken up by the rubber. When this tube is placed and held over a resting mosquito, as it may readily be, the latter drops inert in a few seconds. To aid in finding the mosquitoes in a dark room or barrack a small electric searchlight or acetylene lamp is most useful, and greatly aids in making the catch thorough. With it mosquitoes may be found in dark corners, behind doors, and on articles of clothing, along baseboards and mouldings, and in other places where they might not be detected otherwise.

Certain measures have value as tending to discourage adult mosquitoes and to cause their abandonment of a neighborhood, even though not killing them. The most important of these are the removal of stagnant water, in which they may lay their eggs, and the cutting and clearing of underbrush, high grass, and vines on or in which they take shelter and rest when not

busy. Smoking and anointing the hands and face with certain volatile oils are advocated as measures of personal protection for the same purpose, but they are not to be relied upon. A hungry mosquito will bite through a layer of oil, and the most enthusiastic smoker cannot produce such clouds as to protect his ankles, hands, the back of his neck, and other parts.

Protection from adults. The most effective method of protection from adults is in the use of screening materials, either of wire or of soft fabrics. Houses with wire-screened windows and doors are in general use throughout our country, and add enormously to the comfort and safety of life in the hot season. They have a very great influence in the prevention of all mosquito-borne diseases. In order that full benefit may be realized from screening it is important that the material be kept in good condition, holes patched as soon as found, doors provided with good springs, cracks in floors and openings under the corrugations of iron roofing stopped, and all necessary measures taken to insure the complete exclusion of mosquitoes. For this purpose it is necessary to have buildings and screens inspected frequently, and repairs made as needed.

Bed-nets are in general use throughout all barracks in the tropics, and, if in good condition and properly cared for, they offer adequate protection during sleeping hours, unless the sleeper rolls or tosses in such a way as to bring part of his person against the net, in which event the insects feed through it. It is neither pleasant nor practicable to spend all of the day, or even most of it in bed, and bed-nets are therefore inadequate.

Head-nets are at times of value for night use in campaign, and rarely so for common use in the daytime.

Most mosquitoes, though, do not bite out of doors in the daytime, especially persons who are in motion.

Protection of mosquitoes from infection. Adequate clothing is of course important in protecting from mosquito bites, and should be used for that purpose. In spite of all precautions an occasional mosquito will manage to bite the most careful man. It is therefore important to see that the insects do not become infected with disease, and yellow fever, dengue, and malarial patients, particularly the first-named, should be kept screened or doubly screened during the entire time that they are capable of giving infection. For this purpose it is essential that all cases be known, and early diagnosis and prompt notification are therefore important, especially in yellow fever, which is so deadly and yet is infectious only in its early stages. In addition to screening, the malarial patient should be taking quinine to free his blood from germs. As natives of malarious regions are very apt to harbor the parasite in their blood and to keep the mosquitoes in their neighborhoods infected, it is important to keep them away from barracks and healthy households, and it is wise to build dwellings or barracks at some distance from native towns or habitations. Natives working about soldiers' quarters should be required to take quinine regularly and to observe the general rules of hygiene.

Quinine prophylaxis. Quinine has been much and successfully used as a preventive of malaria. The most extensive use of it has been by the government of Italy, and by the Germans in some of their African colonies. It may be said that there are two methods of using quinine in prophylaxis, and the difference of opinion concerning the value of this method of control arises

from a confusion of them. One method consists in the daily administration of small doses of from two to five grains of quinine. The evidence concerning the value of this method is conflicting and many instances have been cited to show that it is of little or no use. The other method is the administration of doses that might be therapeutic if the person were actually infected, and it is highly effective in keeping down the disease, by reason of the fact that parasites entering the blood are promptly destroyed, and of the other fact that actually infected persons have their peripheral blood freed from parasites and are therefore not infective for mosquitoes. It is probable that a large part of the Italian and German successes with quinine prophylaxis lay in the fact that it was largely a treatment of malaria carriers. Such treatment alone, if it could be carried out thoroughly everywhere, would suffice to eliminate the disease. Like many other desirable measures, this is impracticable. When a command is temporarily placed in a malarious region without other adequate protection, it is advisable to place the whole force on quinine. The most satisfactory dosage is generally about ten grains. This may be given daily, and when it is desired to reduce the total intake of the drug the interval between doses should be lengthened, rather than giving a smaller dose, the idea being to have an efficient concentration of quinine in the blood occasionally rather than to have an insufficient amount present at all times. It should be borne in mind that many persons are very susceptible to the action of quinine and are apt to suffer much discomfort from the use of a dose of this size. In such cases the surgeon must decide whether the individual should use the drug as a prophylactic, and if so, how.

Mosquito brigades. Experience indicates that the work of mosquito "extermination" is more effectively done if regular forces are kept at it to the exclusion of other work, and every tropical or mosquito-infected post should have such a "mosquito brigade." Men kept on the work soon learn the locations and habits of the insects and become expert in destruction or prevention. When the work is left to householders or to general fatigue parties, it is usually neglected and the plague continues unabated.

FLEA-BORNE DISEASES

Plague. Bubonic plague is the most important disease transmitted to man by fleas, and it will be discussed here only briefly, as mention has already been made of it. The disease is due to a small bacillus that is possessed of great vitality, so that the virus may persist for a long time. Extensive investigations in different parts of the world, but principally in India, have clearly demonstrated that the disease is usually transmitted in the manner here indicated, though it is occasionally communicated in other ways. The relation of rats to plague epidemics has already been discussed. A Russian observer states that bedbugs also may transmit it. In Java it was found that body lice taken from plague patients contained plague bacilli. It is possible that they might transmit the disease. Pneumonic plague and its transmission by contact and droplet infection have been discussed, and experiments carried out in Manchuria and later in Manila indicate that during coughing, even when no visible droplets are expelled, large numbers of bacilli are widely disseminated, and the wearing of masks, gowns, and eyeglasses by doctors,

nurses, and others attending patients with this form of the disease is important. The germs are excreted by plague patients in the spit, urine, the pus from ulcers and buboes, and possibly the feces, so that dust-infection and contact may account for some cases. Nevertheless the rat and the rat flea are responsible for the majority of cases and epidemics, and the measures of prevention and control are aimed at these two. The following facts, among others, constitute the reasons and justification for such measures.

Methods of transmission. Rats abound particularly in houses and neighborhoods which, because of poor policing or other sanitary neglect, afford them food, shelter, and breeding-places. They are very susceptible to plague and are probably the natural hosts of the disease. When severely infected they may have the germs in their blood in enormous numbers, as many as 100,000,000 in a cubic centimetre of blood. All rats have fleas, which remain on them until death, when they leave them and seek other hosts, usually rats, but in their absence, men or other animals. Fleas breed in the nests of their hosts, live on their blood, and in biting may readily ingest as much blood as may contain, in the case of plague septicemia, 5000 plague bacilli. These bacilli may remain alive and virulent in the flea's stomach for as long as fifteen days, and then be ejected when the flea bites again, and gain entrance to the wound made by the insect, thus producing infection.

Life-history of rat flea. While the rat flea is the insect principally concerned in carrying the disease, dog, cat, and human fleas may act the part. The following is the ordinary life-history of the rat flea in Bombay. The eggs are laid at all seasons, from one to five at a time, and

hatch in about two days. The larvæ are wormlike and resemble some small fly and weevil larvæ. They live on almost any kind of refuse, often on parental excrement, and, after varying periods of not less than one week, spin cocoons of fine, silky thread, which become covered with dust and rubbish and are difficult to distinguish. The adult fleas escape from these cocoons after one or two weeks and seek a host, as they can only live on fluid food, especially blood. The most favorable temperature for breeding is from 50° to 85° F., and when the mean is above or below this range, breeding stops or is delayed, a fact which partly accounts for the seasonal variations of epidemics. Each species of flea has its own host, which it prefers to all others, but in the absence of that host, and after a period of starvation, it will seek others. The rat flea, for instance, will not usually bite man until three days after the death of its rat host.

It is to be noted, however, that the "rat flea" does not mean merely one species of flea. The common rat flea of the Philippines is not the same as the one most common in India and Java. The life history and breeding habits of rat fleas therefore vary on this account and others. In Java, where the climate is very uniform, the mean temperature being from 73 to 75 degrees Fahrenheit all the year and the humidity not less than 70 per cent saturation, flea breeding and plague spread have no seasonal variation as in India and other places. In Java, the eggs of the common rat flea (*X. cheopis*) hatch in from four to eight days and the larvæ develop into mature fleas in thirty-one to fifty-two days. The adults lived, in the laboratory, only two or three weeks. Humidity is favorable to their development, as when the air is driest fewer eggs hatch and both the larval and pu-

pal stages are prolonged. Infectious plague bacilli were there found in fleas eighteen days after their ingestion. In the Canal Zone fleas begin to leave the body of a rat almost immediately after its death, and all have left at the end of two hours. The common rat flea of England may have its pupal stage prolonged for months, cold weather so influencing it. In rubbish the adults of this flea will live apparently unfed for as long as seventeen months, without rubbish for one month. It is said that this flea will feed on man as readily as on rats, but that it does not breed until it has fed on rat blood. In India the laying of eggs, the development of eggs into larvæ, of larvæ into pupæ, and of pupæ into adults are all subject to marked seasonal variations, being most active in wet and temperate weather and least so under dry and hot conditions.

Prevention and suppression of epidemics. The measures to be taken for the prevention and suppression of epidemics are indicated by the facts recorded above. They must embrace numerous and costly expedients unless the fight is begun in earnest at the first appearance of cases, and the disease eradicated before it has had an opportunity to spread. Failure to take vigorous action early resulted in the spread of plague through San Francisco, so that the work and expense of fighting it had to be continued for years.

General hygiene. General hygiene is of great importance as lessening the numbers of rats and fleas, both of which abound in the presence of filth. Such measures must include the removal or destruction of rubbish and other material in which the rats hide or make their nests, the stopping of their holes or other means of access to walls, floors, and other hiding-places, the pre-

vention of their access to garbage and other food-supplies. They must also include such cleanliness of persons, domestic animals, houses, streets, and communities, as will make the presence of fleas, bedbugs, and lice improbable.

Measures against rats. Special measures should also be adopted against rats, such as their destruction by poisoning, trapping, and disease. The last-named measure is employed by scattering bait contaminated with cultures of a bacillus that causes epidemics among rats, but does not harm man or his domestic animals. The keeping of cats has been advocated as a useful anti-plague measure, and it is probably of value. Old and rat-riddled buildings may need to be destroyed. Good buildings should be made rat-proof by means of concrete cement, and sheet-iron. Stables and warehouses will require particular attention, and their floors, walls, and roofs should be made as rat-proof as possible. Because of the frequency with which rats are transported in ships, all wharves and docks must be freed from them as far as possible, ships from infected ports should be required to anchor offshore, and all cables or chains leading to shore or to other boats should be provided with shields that rats cannot pass. Sewers should be well flushed to keep them clean, and should be screened or barred so that rats may not pass from them to houses or other buildings. Houses or boats known to be infested should be tightly closed and fumigated with sulphur fumes or other poisonous gas that will destroy the rats.

The greatest of all anti-rat measures, however, is cleanliness. A city, a house, a wharf, or a ship may be as "rat-proof" as it is possible to make it, and if it is not kept clean and well policed it may swarm with rats, de-

spite traps, cats, and poisons. On the other hand, a building far from rat-proof may be kept free from rats without any of those means. Given rat-proof food storage and garbage cans for kitchens and rat-proof grain bins for stables, and even they can be kept freer from rats than can other similar places with poisons, traps, and cats, but without adequate food protection.

As helpful in fighting rats it may be mentioned that they can climb almost anything, even an iron pipe or a bamboo pole, may burrow as deep as two and a half feet, can jump upward eighteen inches, "can surmount any horizontal projection of less than six inches if the material be such as they can climb on a vertical surface, and can walk along a thin suspended wire." A rat released 450 feet from shore reached land in six minutes, and one released 1300 feet from shore swam a total of 1500 feet and reached land in fifty-five minutes.

The interesting fact that during a series of epidemics there is evolved a race of rats relatively immune to plague has been observed in India. In plague-free cities (Madras, Raipur, Banda) infected rats show a case mortality varying from ninety to one hundred per cent, while in plague-stricken places (Cawnpore, Lucknow, Poona) only twenty to forty per cent succumb. This immunity is transmitted from parent to offspring and is not acquired.

Measures against fleas. The most important measures against fleas are probably good general policing, the maintenance of clean floors, and the absence of litter and waste in which they may breed; but other measures are also of value, and among them may be mentioned the use of insect-powder and antiseptic soaps on domestic animals, the use of foot-covering and other adequate

clothing, and the use of petroleum on floors and streets, and of putty, paint, and antiseptic solutions in cracks of floors and walls. The Indian Plague Commission reports that for practical purposes flake naphthalin is the most generally effective agent to use against fleas in all stages of their life cycle. It may ordinarily be used in its dry form, but to get it into cracks and crevices it may be dissolved in benzene. For the treatment of rat holes they advise the use of carbolic emulsion (larvacide is such), or of a soap-petroleum emulsion, to which flake naphthalin has been added. A soap-petroleum emulsion may be made by combining eighty per cent of crude petroleum with twenty per cent of whale oil soap (or, presumably, other coarse soap). A room thoroughly washed and sprayed with this is said to be freed from fleas. As previously suggested, the use of crude oil in road-making, as is now much practiced in this country, will probably prove of value in lessening the number of fleas. Fleas may be collected in rooms or houses known to be infected by turning guinea pigs loose in them. The fleas attack the animals, and may then be stupefied with chloroform, combed from the hair, and burned.

Notification of cases. Every case of plague in man or rat should be promptly reported, so that proper measures of isolation, fumigation, disinfection, etc., may be instituted early. All rats found dead, as well as those trapped or otherwise captured, should be tagged with a statement of the time and place, and then examined for the presence of plague. If it is found that they have the disease, active measures must be begun at once in the neighborhood from which they came. All persons afflicted should be isolated and their discharges cared for. Disinfection of houses and effects should follow.

Vaccination. Anti-plague vaccination has been considerably used in India for some time now, and the following statements as to results have been published:

1. In a native of India, who is more susceptible to the disease than Africans, Europeans, and some other races, the inoculation now in force reduced the liability to attack to less than one third of what it is in a non-inoculated Indian. 2. In the one third of cases which still occur, the recovery rate is at least double that in the non-inoculated attacked. The ultimate result is a reduction of plague mortality by some eighty-five per cent. 3. In an inoculated European an attack of plague, if it subsequently occurs, has so far always ended in recovery. 4. The inoculation is applicable to persons already infected and incubating plague, and prevents the appearance of symptoms or else mitigates the attack.

Government reports show that in 1911 there were distributed 1,211,170 doses of plague vaccine, and that among 118,148 vaccinated persons there was a plague incidence of 7.96 cases per 1000, with a case mortality of 39.5 per cent; while among 321,621 unvaccinated persons the incidence was 34.4 per 1000, with a case mortality of 78.6 per cent, indicating results as good as those claimed by the originator of the method and quoted above. Similar results were reported from Java for the same year, yet the statement has been published that the use of vaccine has there been abandoned. The Indian government report just referred to states that the protective power of the vaccine varies with the severity of the reaction it causes.

LOUSE-BORNE DISEASES

Of these typhus and the relapsing fever of most parts of the world have been, in former times, among the world's great scourges, and while often known as jail

fever, ship fever, camp fever, and famine fever, their appearance was by no means so limited as those names would indicate, and palaces and great persons were not strangers to the diseases or their carriers. In peace these diseases are almost unknown in our country, England, Germany, and the other highly civilized Western countries, but in many parts of the world one or both are still rather common, notably in Mexico, where the typhus is known as *tabardilla*, in north Africa, in Russia, in Asia, and especially in China.

The Balkan War and the World War caused such destitution and misery as to permit the wide dissemination of lice and, as typhus was already present in Russia and the Balkans, great epidemics of that disease were set under way and many thousands of deaths resulted from it, especially in Serbia, Roumania, Russia and Poland, and the end is not yet. The disease was also introduced into German prison camps by Russian prisoners, and caused great mortality in some camps.

Brill's disease, of the immigrant sections of some of our cities, is a mild form of typhus.

The Allied armies in Belgium and France in 1917 and 1918 all suffered more or less from a previously unidentified fever which became known as *trench fever*. Careful investigation and experimentation by British and American workers proved that it is conveyed by lice and occurs only in men bitten by body lice, either in those infested in the trenches and dugouts or in hospital attendants receiving and undressing such men or handling their clothing and so becoming louse-infested. It was found:

1. That trench fever is a specific, infectious disease, not related to typhoid or para-typhoid.

2. That the organism causing the disease is a resistant, filterable virus.
3. That the virus is present particularly in the plasma of the blood of trench-fever cases, and that such plasma will produce the disease on inoculation into healthy individuals.
4. That the disease is transmitted naturally by the body louse and this is the important and common means of transmission. The louse may transmit the disease by its bite alone, the usual manner of infection, or the disease may be produced artificially by scarifying the skin and rubbing in a small amount of the infected louse excrement.
5. That a man may be entirely free from lice when he develops trench fever, and that the louse need remain but a short time on an individual in order to infect him.
6. That the virus of trench fever is sometimes present in the urine and occasionally in the sputum of trench fever cases.

The virus was found more resistant to heat than the lice themselves and, as it is found in the excreta of infected lice, clothing soiled with such excreta may give rise to the infection through scratches, even if freed from lice. Moist heat at 70° C. for thirty minutes is necessary to destroy it.

The germ causing typhus has not been identified to the satisfaction of most workers. That causing relapsing fever has been known for a longer period than most other germs causing human diseases, and is a *spirillum*, a motile, corkscrew-shaped organism that is readily detected in the circulating blood at certain periods of the disease.

It has been shown that both of these diseases are ordinarily conveyed by body lice, but there is also evidence that both may be conveyed by head lice, and the investigation of a case of typhus in an American soldier in China suggested to the writer that the crab louse might also carry that disease. Typhus is ordinarily transmitted by the *bites* of the lice, but this is only exceptionally true of relapsing fever, of which disease the insects are contaminative carriers, and in which infection usually occurs when the insect is crushed and its juices rubbed into the skin by scratching. There is evidence that both diseases and the power to infect with them may be passed by the lice to their offspring.

The following extracts from a circular memorandum issued to the British Expeditionary Forces in 1918 are of interest:

Lice normally live from one to one and a half months, their longevity depending upon the favorableness or otherwise of their environment.

The female louse reaches maturity in seven to eight days, and then commences to lay eggs. Under favorable conditions each female lays about ten eggs a day throughout the remainder of its life; in all, as many as three hundred eggs may be laid by one individual. The eggs, when laid in suitable surroundings, hatch out in about eight days, but this incubation period is liable to be affected by various conditions. Since the female begins to lay eggs when eight days old and the incubation period of the eggs under normal circumstances is about eight days, the period between successive generations will ordinarily be about sixteen days.

Lice lay their eggs on hairs or fibres of which the clothes are composed, and show a marked preference to rough, filamentous fabrics such as wool or flannelette. They will, however, readily lay on quite smooth fabrics such as silk or sateen, so that garments made from these materials afford no pro-

tection against lice infestation. Eggs are usually laid on the inner surface of clothing, especially on the seams, but they are not limited to underclothing; outer garments, such as service dress, braces, etc., may commonly be heavily infested. The issue of clean underclothing is therefore useless as a preventive measure unless all the other clothing is disinfested. Each egg is firmly cemented to the hair or fabric on which it is laid, and cannot be removed by any solvent.

It is important to realize that the body louse may also lay its eggs on the hairs of the body, they may frequently be found on the hairs of the chest, armpits, and elsewhere.

Temperature has a marked effect upon the laying of eggs. The most favorable temperature for oviposition is 32° C., which is the usual temperature of the skin when comfortably clothed. Eggs are not laid at a temperature below 20° C., and this is one reason why the removal of clothing at night has an influence in preventing the increase of lice.

Lice eggs are susceptible to surrounding conditions and their incubation period and vitality are readily affected by adverse circumstances. They may survive immersion in cold water or even exposure to frost for several days, and then if placed under suitable conditions may hatch out. Eggs do not hatch at a temperature below 22° C. They hatch when kept at 25° C., but the incubation period is prolonged to about 16 days; at 30° C., may hatch between 7 to 14 days; at 35° C. hatching may occur between 4 to 8 days; at 38° C. hatching is retarded; and when kept between 40° to 45° C., eggs die without hatching. A temperature of 55° C. is rapidly fatal to eggs; at 60° C. they are killed in about five minutes. When the temperature fluctuates, as happens when clothing is removed at night, hatching, if it occurs at all, may be delayed up to 35 days.

The characteristic appearances of eggs under different conditions are as follows:

Recently laid eggs: Goblet-shaped, with cap at the end not attached to the fabric. In color they are gray with a dry sheen.

Eggs 5 to 10 days old: Pale orange in color, due to the young louse developing inside.

Empty eggs: Similar in shape and color to recently laid

eggs, but are hollow and more transparent and open at the end, where the cap has burst away.

Eggs being steamed or boiled: Opaque white with wet sheen; on drying they collapse and shrivel.

Eggs after subjection to high temperature in a disinfector: shriveled and scorched.

Immediately after birth lice begin to feed, and continue to do so at frequent intervals throughout life, more particularly when the host is at rest. Lice apparently bite more frequently at night than by day. The bites may produce considerable irritation, which is accentuated if the lice are crushed and their juices come in contact with the wound. Many men acquire tolerance towards lice bites after they have been infested for a couple of months, and experience no particular discomfort from the presence of the insects. Scratching consequent upon the irritation of the bites may be responsible for a variety of skin affections which are often troublesome and difficult to cure. It is through bites also that the virus of typhus fever, relapsing fever, and trench fever are conveyed by lice to man. Relapsing fever is caused by the juice from crushed lice being rubbed into the bites.

Lice are spread mainly through contact with verminous persons, more especially when men are huddled together in billets and dugouts. They tend to wander when men's surroundings are warm and comfortable, for instance, when men are sleeping closely crowded together. Similarly the high temperature of patients with fever is repellent to lice, and they wander away in search of more congenial surroundings. In this lies the danger of approaching without due precautions too closely to lice-infested cases of typhus or relapsing fever. Lice will also forsake persons who have recently died, the wandering in such cases being due to hunger. Lice may also be disseminated amongst men by contact with verminous clothing, and clean clothing may become infested when left in proximity to verminous clothing. Stray lice may also be picked up in railway carriages and other places frequented by verminous persons.

Of these modes of dissemination the chief is from man to man, especially when crowded together in warm surroundings;

blankets ordinarily appear to be only a subsidiary source of infection, and the risk of infection by stray lice in railway carriages is negligible as compared with other sources of infection. The same is true of "dugouts"; the common belief that certain dugouts are more liable to produce lice infestation than others is not supported by evidence, and the phrase "lousy dugouts" is a misnomer. "Dugouts of lousy men" more truly describes the real state of affairs.

Lice are extremely sensitive to environment, and any deviation from normal conditions affects them greatly. The optimum temperature for their existence is about 30° to 32° C. At temperatures lower than this they become sluggish and feed less frequently; at 0° C. they are immobilized and cease feeding. At temperatures slightly above 32° C. they become extremely active and endeavor to escape to cooler surroundings; they die in a short time at 45° to 50° C., and temperatures a few degrees higher than this are rapidly fatal. Lice when removed from the host very soon starve to death, especially if kept warm, as then their metabolism is more active, and they succumb more quickly than if kept cool. Young lice die more easily than adults; one or two days' starvation usually suffice in their case. When lice-infested clothes are laid aside, the lice cannot in any circumstances survive for more than nine days, and commonly not so long. This does not apply to the eggs, which, as already stated, may remain alive for longer periods.

PREVENTIVE MEASURES

The foregoing facts in regard to the habits and life-history of the louse indicate lines along which measures for combating lice infestation may usefully be directed.

Such measures comprise:

1. The detection of men who are infested with lice.
2. The disinfestation of all clothing and bedding belonging to lice-infested man.
3. The cleansing of the man himself — bathing.
4. Cleansing of billets, etc.

The relative importance of these measures must be realized. The early detection of lice-infested men is essential if spread

of lice amongst a unit is to be prevented. In the main, lice are confined to the underclothing and service dress; few are found in blankets or on the man himself. Billets, trains, dugouts, etc., do not usually harbor lice, and may be regarded as uncommon sources of infection.

It therefore follows that attention should be concentrated upon frequent inspection of men to detect cases of lice-infestation, and upon thorough and systematic disinfestation of the men's kits, including all underclothing and service dress. Where possible, blankets should also be disinfested, but if facilities are not sufficient to disinfest both clothing and blankets at one time clothing must be given preference. It is useless to disinfest blankets without at the same time disinfesting all underclothing and service dress. Similarly it is useless to bathe and cleanse men without at the same time disinfesting all their clothing.

PERSONAL CLEANLINESS

Routine inspection. All troops should be inspected at least once a week by company officers in conjunction with medical officers. This inspection should include examination of the men for lice bites and "nits" (eggs) and examination of the clothing for lice and their eggs. All reinforcements on arrival in the country and all drafts before proceeding to the front should similarly be examined in order that if lousy they may appropriately be dealt with. All men joining or leaving a unit should likewise be inspected even if their absence is only temporary, as, for instance, when going on leave.

Any men who on inspection are found to be infested with lice should forthwith be bathed and all their kit (service dress, underclothing, and blankets), disinfested. Men should be encouraged to report at once when they discover that they are infested with lice.

Bathing and cleansing. Whenever practicable, every man should have a bath at least once in ten days, and a complete change of disinfested underclothing after the bath. A paraffin soft soap useful for bathing purposes when men are liable to infestation by lice is made as follows: Three pounds of soft

soap are warmed slowly with half a pint of water; when hot the soap is removed from the fire and mixed slowly with five and a half pounds of crude paraffin oil. A useful cresol soft soap may be made by adding 2½ per cent of cresol to the above.

In arranging a segregation camp, the following points must be borne in mind:

(a) A site must be selected affording accommodation for the tenting of twice the number of men for segregation.

(b) The camp must be divided into two sections — an "infected" section and a "clean" section.

(c) Ample facilities for baths and means of disinfecting by heat or by sulphur dioxide must be provided. All lice and nits infesting the man's kit, clothing, and body must be destroyed.

(d) Arrangements must be made for transferring the men in batches from the "infected" to the "clean" section of the camp, after they have been cleansed by bathing and after their kit, clothing, and bodies have been disinfected.

(e) Effective measures must be taken to prevent any communication between men still in the "infected" section of the camp with those in the "clean" section.

(f) Men should be inspected daily during the period of segregation for signs of sickness and for presence of lice.

FLY-BORNE DISEASES

Sleeping sickness. In addition to typhoid and other diseases discussed in preceding parts of this book, in which the fly acts as a simple carrier of infection, but does not actually introduce it into the body, the sleeping sickness of Africa is a very important disease. It is introduced by a biting fly, and is caused by a small animal parasite very much like that causing surra in horses in the Philippines and other places.

The only means of prevention yet known are the avoidance of fly bites, the cleaning of undergrowth from

near streams, and the avoidance of infected localities. The disease has spread widely throughout Africa within a comparatively few years, has caused enormous fatalities, and practically depopulated large districts. All of the European countries having colonies south of the Sahara have done much work and spent much money in their efforts to control it. Whether or not there are two or three kinds of sleeping sickness, caused by two or three species of trypanosomes, is not at present settled, but at any rate all African sleeping sickness is trypanosomiasis and is transmitted by tsetse flies.[1] African antelope appear to be reservoirs of the disease, and the question of their extermination has been discussed. The value of proper clothing as a protection from fly bites is not to be forgotten. It appears that sleeping sickness is relatively more common among European women in Africa than among the men, a fact probably partly accounted for by the less degree of protection of this sort afforded by the women's clothing, especially by their stockings as compared with the men's leggings or trouser legs.

Three day fever. In the Balkans, in many places in or about the Mediterranean, in India, and elsewhere, a short, sharp, painful fever, called "three day" or "sand-fly fever," has been found to be carried by sand flies or midges of the genus *Phlebotomus*, very small insects that breed in crevices of stone walls and similar places. The disease is not fatal and bears a clinical resemblance to dengue. Prevention lies in avoidance of bites, a difficult matter where the flies abound, as they readily pass through most mosquito screening.

[1] This disease is not related to the "sleeping sickness" or lethargic incephalitis which has prevailed in the United States and Europe for the past year or two.

TICK-BORNE DISEASES

The most important tick-borne diseases that have been well studied are the African relapsing fever, due to a spirillum, and the spotted or tick fever of western Montana, due to an unknown organism. The latter disease may affect American troops, as Fort Missoula is in the country in which it occurs. No case has yet appeared in a soldier. Both of these diseases may be transmitted by ticks that have bitten sick persons, or by the young of such ticks. The methods of prevention thus far known to be of value are the avoidance of infected districts and of tick bites. In the case of spotted fever the season is short and the danger is slight, except from the first of March to the middle or end of July. If infected regions must be visited, the use of adequate clothing and of head-nets and bed-nets will be of value, but probably not absolutely protective. Wood-ticks, such as convey spotted fever, disappear as forests are cleared and the land cultivated. The ticks that convey the African fever abound principally in rest-houses and old camps, and cleanliness, avoidance of old huts and old camp-sites, and the use of nets, would seem the best measures of protection.

DISEASES BORNE BY BEDBUGS

As stated above, a number of diseases have been credited to the agency of these pests, and the evidence incriminating them is sufficiently strong to make their avoidance and destruction a necessity, as well as an æsthetic measure. The mere fact that they are and for an unknown period have been closely parasitic on man is presumptive evidence of the possibility of one or more

human diseases having adopted them as carriers, because a study of the insect-borne diseases that have just been discussed shows that each of them is borne by an insect closely associated with the animal host. In most instances in which the carrier is not a parasite especially associated with man himself, for example the rat flea and the tsetse fly, it could reasonably be claimed that man is only accidentally the subject of the diseases, which in the instances cited belong to the rat and the wild game. Bedbugs are so generally recognized as vermin and indicators of uncleanliness that their presence constitutes a cause of shame in a well-regulated house or barracks. The avoidance of diseases transmitted by them depends on scrupulous cleanliness of houses, beds, and bedding, and the avoidance of those that are not clean. Soldiers, though living in clean surroundings, may expose themselves to bites in seeking sexual indulgence or drink, and they should be taught by precept and example not to do so.

CHAPTER XV

VENEREAL DISEASES

The term venereal is usually applied to the diseases resulting from illicit and impure sexual intercourse. The principal members of the group are syphilis, chancroid or soft chancre, and gonorrhœa. In a general sense the adjective is truly descriptive, but, as stated before, it is not always so, and all of these troubles may be contracted by persons absolutely innocent of illicit connections or even of proper intercourse. It is, however, so generally true that in soldiers, at least, the diseases result from improper conduct, that they are assumed to be "not in line of duty," and a report to the contrary requires special explanation.

General causes. These diseases are particularly frequent in youth and early manhood, and it is stated that "about ninety-five per cent of all cases of gonorrhœa occur between the ages of sixteen and thirty." The reasons for this are numerous, and some of them may be summarized as follows:

1. This is the period at which sexual desire and power are at their maximum. After the age of thirty some decline in both has usually begun.
2. It is also a period in which judgment is not matured, self-control not well developed, and ignorance not dissipated, so that the future wife and family exercise no claims and venereal diseases are regarded as trifling.
3. Manhood and virility are synonymous terms, in

common usage as well as in the dictionaries, and youth delights in demonstrating its manhood.

4. Most men are married by the time they reach the age of thirty, and are less apt to be exposed to infection thereafter.

The soldier is probably more apt to contract venereal diseases than the young civilian, because his associates are practically all males; his topics of conversation are largely such as are only handled in "stag" gatherings; he is removed from the restraints of the family and of the public opinion that can most influence him, that of his friends and acquaintances at home; he may at times find it difficult to obtain access to other female society than that of prostitutes, and these are always to be found. He may also drink a bit to demonstrate his manliness, to relieve his loneliness, to be companionable, or simply because he is "a young man, void of understanding"; and then, with judgment perverted and desires inflamed by alcohol, he forgets danger and seeks intercourse where he can most readily obtain it.

For many years our army had the highest non-effective rate of any army publishing its statistics. The venereal rates of the American army during the World War were only one third to one half as great as for the preceding twenty years, and apparently much more favorable than those of the other armies engaged. This was particularly gratifying and interesting in the A.E.F., where the opportunities for contracting venereal disease were plentiful and alluring to a degree not known in the United States and where the following circumstances seemed to make for a higher rate:

(a) Many men in the United States were near enough to their wives or mistresses to be able to indulge in

safe intercourse at times, and so miss the call of prolonged abstinence.

(*b*) They were more nearly under the influence of the public opinion of their home communities. The public opinion of a French community is much more lenient toward the man of loose sexual habits than is that of America.

(*c*) Discomfort, cold, wetness, lack of privacy, boredom, and loneliness were all more marked in France.

(*d*) Street solicitation by prostitutes is everywhere in France more common, open, and attractive than anywhere in America.

(*e*) Alcohol was more easily, cheaply, abundantly, and openly obtainable throughout France than in the neighborhood of any post or station in the United States.

In spite of these facts the rates of both incidence, as determined by inspection, and of non-effectiveness, as shown by sick records, were extraordinarily low. This surprising state of affairs led the writer to undertake an investigation as to the causes of these low rates, with the result that he brought out the following facts and reached the following conclusions in regard to that army, time, and place:

The most important factor in keeping down venereal rates is chastity, and the most important fact in accounting for the low rates in the A.E.F. was that 34 per cent of men, as indicated by 13,648 unsigned answers to a questionnaire, remained chaste during their entire stay in France, a period varying from eight months to two years and probably averaging about ten months. The next most important factor was infrequency of in-

tercourse, as my investigations indicated an average of thirty unprotected sexual contacts or ninety with prophylaxis for each resulting case of venereal disease, and one third of all men in France indulged less than ten times each, many of them but once or twice, thus greatly reducing the rate in comparison with the final third, who indulged more than ten times each, very many of them much more. The third factor in importance was the use of prophylaxis which, as shown above, appeared to reduce the likelihood of infection to one third of what it was without prophylaxis; that is, to one infection for ninety exposures instead of one for thirty.

A similar inquiry now in progress in the Army in the United States shows some differences in results, judging from a study of about 12,000 replies thus far received. The percentage of chaste men is almost the same, being about thirty-four. The inquiry covered a period of one year for each man. The effectiveness of prophylaxis appears to be somewhat less, resulting in a reduction of venereal incidence to about one-half of what that was without its use. Another interesting and fortunate fact is that the prostitutes in America seem less dangerous, less infective, than those met abroad, as shown by a lower infection rate in comparison with the number of exposures either with or without prophylaxis. Apparently about ten per cent of men who indulge in promiscuous intercourse become infected in the course of a year.

It is very difficult to estimate the relative importance of the various factors influencing men to keep chaste, but it was my opinion, as a result of investigation, that they were important in somewhat the following order:

(*a*) Early home training in self-control, morality, re-

ligion, loyalty, and sense of responsibility to others, and character. I believe that this early training averaged much better for the draft army, which was a section through total American manhood, than in the old professional army, which had an undue proportion of the poorly trained, the adventurous, the reckless, the unstable, and the feeble-minded, and that this difference accounts more than any other one thing for the better rates.

(*b*) The great campaign of education and propaganda against venereal disease which was carried out in all camps and cantonments in the United States, the activity of the Y.M.C.A., the Red Cross, the Y.M.H.A., the K.C., and other societies in carrying on similar work, the attitude of General Pershing and the pressure brought to bear to make officers feel their responsibility for the conduct of their men, and other influences contributed to form within the army a volume of public opinion definitely favorable to chastity and unfavorable to prostitution and to dealings with prostitutes. After self-respect, loyalty and character, it is probable that the public opinion of the community or organization in which one lives is the most powerful controller of individual conduct.

(*c*) The placing of houses of prostitution "out of bounds" was very important, as free access to them uniformly caused increase of illicit connections and rise of rates uniformly followed such increase. Efforts to control, regulate, and make safe the practice of prostitution usually fail, and they had no part in influencing the low rates in France.

Absence of women from some areas occupied by troops of course reduced the opportunities for contact in those regions.

(*d*) The liberal provision of entertainments, by athletics, theatrical performances, and other means, prevented many contacts which otherwise would have been brought about by idleness and boredom.

(*e*) The fear of punishment and of getting venereal disease doubtless kept many men from intercourse.

(*f*) Lack of funds was an occasional cause of abstinence from intercourse, but, as twenty-seven per cent of men getting venereal disease had not paid for the infecting contact, that was not a guarantee of virtue.

The fact that one third of our army in France, where the temptations were great and particularly alluring, remained chaste should be emphasized by company officers in talking to their men, as many young men feel ashamed to be chaste or to avow a chastity which they practice. If officers let their men know that they expect chastity they will afford strong support to men who desire to practice it.

General measures of prevention. The company officer cannot expect to work a revolution in the morals of his men, or to make chastity a general characteristic of them, but he can exercise some influence in that direction by his personal conduct and example, by choosing non-commissioned officers who will probably do the same, by making the soldier's surroundings pleasant and attractive, and encouraging him to find his amusement and recreation in the post, by providing good

reading-matter and helping to make the most of the post exchange as a place of recreation and amusement, and by giving his men instruction as to the dangers of venereal disease and the sanity, healthfulness, and safety of sexual control and continence. Recruiting officers can do much by careful selection of men, as it is a well-known fact that the great number of admissions to sick report for venereal disease is made up by a relatively small number of men, the majority of whom are of the less desirable class of soldiers. Drink, poor home-training, ignorance, and lack of self-respect lead these men to places and practices that their more decent comrades avoid.

As man is the only carrier of these diseases, as they are transmitted in nearly all instances by direct physical contact, and as early diagnosis, isolation, and treatment enable us to do much in the control of other transmissible diseases, it seems reasonable to believe that similar measures, if generally enforced, would produce great results in these. There can hardly be any doubt that if all cases of venereal disease were promptly reported and then isolated and kept from sexual intercourse until well, the diseases would be exterminated. These are such chronic troubles, however, and require such prolonged and careful treatment to insure a cure, that such a plan is quite impracticable. Many efforts have been made to approach it though, by the regular examination of prostitutes and their isolation and treatment until free from contagious lesions, and similar measures have been adopted in regard to soldiers in our own service. But it cannot be said that the diseases have been brought under control by such measures, and the reasons are fairly obvious. It is practically impossible for an examiner to

know positively that a given person is free from venereal disease. Chancroids are easy of detection, but both syphilis and gonorrhœa may linger, capable of transmission, without giving any indications of their presence that can be detected by the inspection that the examiner of large numbers can give. This is true in the case of soldiers, and much more so in that of prostitutes, who, moreover, are adept in the removal of slight signs that may be present, and whose interest lies in escaping isolation. Most prostitutes are such for one of two reasons, either for the pleasure and excitement they find in the life or for the money they can make out of it. In either case their object is defeated for the time being if they are isolated. Furthermore, there is always and everywhere a large amount of clandestine prostitution, that is, that practiced by women not openly professing to do so; and as registration of the prostitute is a necessary preliminary of her regular examination, a large amount of venereal disease thus escapes detection. Naturally, too, the amount of this clandestine prostitution increases with the severity and strictness of the measures of control over that which is licensed. As examinations are not usually made more than once a week, and in many instances not so often, a woman may develop a contagious discharge or sore the day after examination, and transmit disease to fifty men before being examined again. A prostitute living near a Western post stated that she usually had intercourse with from fifteen to twenty-five men on the night following payment of the troops, and with from one to five or six men on other nights, and investigations in Chicago, New York, and elsewhere have since shown that that is no unusual record for a prostitute.

Venereal prophylaxis is a form of treatment or local disinfection provided at all posts and stations for the use of men who expose themselves to venereal disease, and orders prescribe that men so exposing themselves without resorting to its use afterward shall be tried by court-martial. The use of prophylaxis should be supervised by a trained attendant and consists of:

1. Urination.
2. Thorough washing of the genitals with liquid soap and warm water.
3. Washing with bichloride of mercury solution, 1-1000.
4. Injection into the urethra of about a teaspoonful of 2 per cent protargol solution not more than two days old. This should be retained for five minutes.
5. Drying of the parts and thorough inunction of 30 per cent calomel ointment into all parts of the external genitals. This is not to be rubbed off.
6. Wrapping the parts in paper (to prevent soiling of the clothing) and avoidance of urination for four hours.

In this sequence of treatments the urination and the protargol injection are especially for the prevention of gonorrhœa, the washing with soap and water and with bichloride solution for the prevention of chancroid, and the washing, the bichloride, and the calomel ointment for the prevention of syphilis.

This is not a certain preventive of venereal disease, and it is improbable that any method of prophylaxis can be such, as there is no reason to believe that the infecting organisms may not occasionally gain entrance into the tissues in such a way as to be beyond the reach of disin-

fectants and to cause infection before withdrawal has taken place.

As stated above, this form of prophylaxis appeared to reduce the liability to infection to about one third of what that was without its use in the A.E.F., and to about one half of what it is in the United States. The evidence does not indicate that it is much, if at all, more efficacious against one disease than another, the variations in the percentages of the various diseases following use or neglect of prophylaxis being no greater than occurred in different years before it came into use.

The following data are derived from the unsigned answers of 6000 men in the Army in the United States who acquired venereal disease in the latter half of 1919 and up to the first of April, 1920. The information was obtained in confidence and with all inducements for falsehood removed. The answers were given voluntarily. The average length of service of the men was 26 months. The diseases were proportioned as follows: Gonorrhœa 65.4 per cent, chancroid 11.5 per cent, and syphilis 15.1 per cent. It is probable that some of the cases of chancroid will later prove to be syphilis. Fifty-four per cent of the cases were contracted in the neighborhood of the posts where the men were serving, the remainder at distant places, almost one fifth in foreign lands. Only a trifle over one fourth were contracted in houses of prostitution. The average time from date of exposure to date of detection was 17 days, a period probably longer than that of incubation but influenced by the fact that many men were away from their commands and from inspections at the time they developed their diseases. Drink was a factor in only 15.3 per cent of cases, a fact doubtless related to the national prohibi-

tion of alcohol. Only forty-eight per cent of the infective contacts were followed by the use of prophylaxis, the average period elapsing between exposure and use by the men who did use it being two and one third hours. Less than three fifths of the men paid any money for the infecting intercourse. The price paid by the others averaged $3.10. The average number of exposures in the preceding year was fourteen; the number of exposures followed by prophylaxis for each infection following its use was 15.3; the average number of unprotected exposures for each infection following neglect of prophylaxis was 11.3. These figures relate entirely, as stated above, to *infected* men. Inclusion of those escaping infection materially raises the number of exposures for each infection.

The following figures may also be of general interest:

Among the first million drafted men reporting to mobilization camps, 2.88 per cent were found to have venereal disease; among the second million 5.8 were so affected. The difference may probably be accounted for by the fact that in the first half-million examined venereal disease was a cause for rejection by local boards, and men found by them to have venereal disease were not sent to camps. When the second draft was called it included men who had previously been rejected by local boards because of venereal disease, so that the proportion of cases among these men was unduly high, just as it had been unduly low among the first comer. These men were all between the ages of twenty-one and thirty-one, the ages at which venereal diseases are most prevalent. In 1917 the army had 73,762 cases of venereal disease in a mean strength of 678,579 men; in 1918, 227,861 in a mean strength of

2,518,499 men; from January 1 to September 9, 1919, there had been reported in the United States 25,782 cases in a mean strength of 448,949 men, while in the same period there had been placed on sick report in the A.E.F. 35,756 cases in a mean strength of 1,002,935. This does not represent all cases found in the A.E.F., but only those excused from duty because of their disease.

The total number of individuals in the army from January 1, 1917, to November 11, 1918, was 4,185,220; therefore the total infections reported, including those brought in with the draft, equaled about 8.6 per cent.

Careful analysis of various reports indicates that the venereal disease incidence in the Army in the United States in 1918, that is, new cases developed after entry into the service, was at the rate of 45 cases per thousand men per annum. Of the men taken into the service in that year, less than three per cent of the whites and more than twenty per cent of the colored had venereal disease when they entered the service, and those figures may fairly be taken to represent the prevalence of venereal disease among civilians between the ages of twenty-one and thirty-one.

The venereal incidence rate — that is the number of new cases occurring among 1000 men of the army in the course of a year — was for the period:

1899 to 1904	149.92	1911	163.49
1905	178.72	1912	136.70
1906	158.91	1913	97.22
1907	167.82	1914	110.69
1908	174.84	1915	107.71
1909	177.46	1916	103.35
1910	155.51		

Instruction as to the nature and danger of the venereal diseases may be derived from the following consideration of them.

GONORRHŒA

Gonorrhœa or "clap" is a disease of such great antiquity that it may be as old as prostitution itself, and the first half of the fifteenth chapter of Leviticus indicates that Moses knew it and also knew that it was conveyed by contact, and that he provided rules to prevent its spread.

Cause. The disease is due to a bacterium known as the gonococcus. This organism occurs constantly in the gonorrhœal discharge, and the disease can be produced by artificial inoculation with it. It is very hard to cultivate artificially, and is readily destroyed by drying, heat, and antiseptic drugs. It may live for some time on towels or linen, or in warm water. It grows on mucous membranes, and those of the genital and urinary passages, of the eyes, mouth, and rectum may be affected.

Age. The young are more susceptible to its action than the old, and children are particularly easy of infection. The disease once started in hospitals for children or in orphan asylums, especially among little girls, is apt to become epidemic.

Transmission. Transmission is usually by sexual contact, but it may occur through mediate transfer, as by towels, soiled hands, penis syringes, or urethral sounds. Such methods are uncommon, however, and little credence can be placed in the story of the man who thinks he got it from a water-closet seat. Strain, as from heavy lifting, can never cause the disease, though often alleged to do so.

Incubation — Symptoms. The incubation period varies considerably, and the disease may manifest itself within a day of the impure connection or it may not do so for ten or twelve days, or for some intervening period. It usually begins with slight burning on urination, which leads the subject to examine his penis, when he may find the margins of the urinary opening red and somewhat puffy. Or the lips of the opening may be stuck together when he arises in the morning, and a drop of clear discharge, like white of egg, can be expressed from it. The symptoms increase rapidly, and within another day or two the disease is at its height. The discharge is then more profuse, is creamy in color and consistency, the penis is sore, and urination painful. Erections may be frequent and painful, especially when the patient is in bed and when the inflammation has extended out into the body of the penis. These may cause intense pain, and the organ may be curved. This condition is known as chordee. The inflammation may extend to the bladder, causing very frequent and painful urination; to the testicles, causing swelling, pain, and sometimes abscess formation, and often leading to stoppage of the duct leading from the testicle to the seminal bladder, and so rendering the former useless as a procreative organ. Germs may be carried to the lymphatic glands in the groins, and cause them to become very painful, tender, and swollen, and oftentimes to suppurate. This glandular swelling constitutes a bubo.

Persistence. These various troubles may cause great pain and suffering, but, in the absence of further complications, they lessen in severity after a time, usually from one to six weeks, the swellings subside, the discharge diminishes or ceases, and the patient may think

he is well. Or he may recognize that he has gleet. This is a condition not attended by other symptoms than the presence of a small, clear drop of discharge in the early morning, and it is usually regarded as of no importance. It is gonorrhœa, however, and is capable of setting up the disease in others, and many unfortunate brides have been so infected. It may persist for months or years, and other manifestations of the disease may do likewise. Many men have suffered or died from the results of gonorrhœa ten, twenty, or more years after they thought themselves cured of it; or, worse still, they have seen their wives or children sicken, become blind, or die as the result of it, and have had no thought that they themselves were responsible for the calamity.

Complications. The complications of gonorrhœa are so numerous, so serious, and some of them apparently so remote that there is no space to discuss them here, but some of them will be mentioned. *Stricture* is one of the most common. It is often present when a gleet persists. It may cause obstruction of urine, great suffering, and serious or fatal kidney disease years after the acute gonorrhœa. The principal symptom is obstruction, usually partial, to the urinary stream. *Inflammation of the prostate gland* may develop and last for years, causing pain in urination and perhaps during defecation, pain deep between the legs, marked nervous symptoms, and general invalidism. *Gonorrhœal rheumatism,* or joint inflammation, is always hard to treat, causes great pain, and tends to last for a long time. It may result in great deformity and permanent crippling. *Tendon inflammation* may also occur and produce symptoms much like the joint troubles. Pain and tenderness of the heel

or of the great tendon leading upward from it may result from gonorrhœa and prevent marching. *Eye diseases* of at least two kinds result from this disease and always endanger and frequently destroy the sight. Gonorrhœa is one of the great causes of blindness, the disease often developing in children at the time of birth, from infection entering their eyes from their mothers' genitals, the mothers often being infected by their husbands, who thought themselves cured before marriage. The disease may also be conveyed to the eyes by the hands after urinating or wiping away discharge from the penis. It may be transferred from one person to another through the medium of towels, wash-cloths, medicine droppers, and other things in common use. *Blood-poisoning*, that is, the diffusion of germs through the blood, may result from gonorrhœa and may cause death. *Heart disease* may be a complication, and often accompanies blood-poisoning. It may cause death early or may be apparently recovered from, and the heart may break down from the damage done it only after the lapse of years. Owing to the levity with which the disease is often regarded, this complication may not be detected at the time of its occurrence.

Danger to others. As already stated, the subject of gonorrhœa is a source of danger to his companions and his family, and in military life it is desirable that he should be confined to hospital, at least during the time of most active symptoms, and that all men should be cautioned against using the towels or linen belonging to others. No man worthy the name would deliberately infect another person with his disease, but many men unintentionally do so. All should be instructed to abstain from sexual intercourse until entirely cured.

CHANCROID

Chancroid, soft chancre or soft sore, is the least important of the diseases here discussed, as it is a local infection and does not do the general damage or assume the manifold and insidious forms that often characterize gonorrhœa or syphilis.

Cause. The typical and usual soft chancre is due to a small bacillus which bears some resemblance to that causing plague, but ulcers may be produced on the penis, as elsewhere, by other organisms.

Incubation. The incubation period varies from one to ten days, and its length probably depends on a number of factors, such as the degree of infection in the woman, the presence and size of scratches or abrasions on the penis, and the violence, length, and frequency of the infective intercourse.

Symptoms. The disease begins as a small ulcer, or sore, which may be no larger than the head of a pin. The favorite location is in the depression or groove just back of the head of the penis, though it may be anywhere on that organ. Many sores may show at once, or one may appear at first and others develop later. The ulcer enlarges and deepens, the surrounding parts are red, swollen, and tender, and the surface of the sore more so. A thin and usually moderate discharge is present, and is highly infectious, and its presence causes the development of the secondary sores. Under proper treatment the ulcers can usually be healed in a few days or weeks, but if neglected or improperly treated or in inaccessible positions, they may spread and produce considerable loss of tissue, half or more of the head of the penis being sometimes destroyed. The base of the

ulcer, if not irritated, is usually soft as compared with the base of the syphilitic chancre, hence the name soft chancre. Occasionally this sore may appear on the bag, on the lower hairy part of the abdomen, or anywhere, in fact, that the virus has entered the skin.

Complications. The most frequent complication is bubo, which occurs in about one fourth of all cases. It is very painful, causes lameness, fever, and may require operation.

Prevention. The methods mentioned as tending to protect from gonorrhœa are equally applicable here, except that irrigation would not be particularly valuable as the sore usually develops externally rather than in the urethra. Early and proper treatment is required to produce speedy healing and lessen the tendency to the formation of buboes, and soldiers should report promptly for it.

SYPHILIS

There has been much speculation and discussion as to whether syphilis, or pock, originated in the old world or the new, whether the Spaniards brought it to America, or took it from here. At any rate, the disease spread throughout Europe in the century following Columbus's voyages, and it has prevailed throughout the world until the present time, and is now seen in all ranks of society and all walks of life. It is the most dreadful of the diseases considered in this chapter because of its chronicity, the long time required for its treatment, the great variety of its manifestations, the number and seriousness of the conditions resulting from it, and the fact that it is the disease affording the most striking examples of the sins of the fathers being

visited upon the children. The disease cannot be described or adequately discussed in the space allotted here, but a very brief outline of it will be given, in order to enable the line officer to impart some degree of information about it to his men.

Cause. Although the disease has been known and industriously studied for centuries, it is only lately that its cause has been known. This is the very fine and delicate spiral organism mentioned in a preceding chapter as a *Treponema.*

Transmission. The commonest method of transmission of syphilis is through sexual intercourse, and this is especially true as regards soldiers, to whom many of the other avenues of infection are not open. But there are such other avenues and they are numerous; and innocent victims of this disease are therefore more numerous than those of gonorrhœa or chancroid. Among such methods we may mention the following:

Heredity. The disease may be inherited from either parent, and may infect the child in the womb and cause its death there, cause it to be born diseased, or to be born apparently well and develop the disease soon after. Or, in rare cases, it may be born apparently well and continue fairly so for years, and only show the disease in recognized form when it reaches the age of puberty.

Contact, especially such as kissing, is a fairly common method of transmission. Ulcers or sores in the mouth are a common manifestation of the disease, and in such cases the organisms are present and sometimes numerous there. The saliva or discharge from such a mouth is highly infectious, and, if brought in contact with a slight scratch or sore, will give rise to the disease. Children and girls have many times been infected by kissing

persons so affected, and syphilitic children may by this means infect the nipples of their wet nurses. For this reason, also, the spoons, cups, and other eating utensils and pipes or cigarette-butts that have been used by syphilitics, are dangerous. The blood and discharges from sores on syphilitic persons are infectious, and nurses and doctors are occasionally infected in dressing or operating upon such cases. Several instances of the kind have occurred in the army. Barbers may receive infection if they get wounds or scratches contaminated by the saliva or blood of their patrons, and they may also transmit it through scratches or cuts. Dentists and their implements, if not clean, may transmit it.

Incubation. The incubation period of syphilis, the time intervening between the infective intercourse and the first manifestations of the disease, is long. It is never less than ten days, is usually nearer a month, and not very rarely it may be two months or more before the chancre shows, while in a considerable proportion of infections, probably something between a tenth and a fourth, the chancre does not show at all and a condition of latent syphilis exists. In such cases it may be many years before any manifestation of the disease is recognized. As a rule, however, the incubation period is from two weeks to one month, after which time the primary sore or chancre develops at the point of entrance of the virus. This fact may be of value in determining the manner of infection. If the chancre be on the genitals, it is usually a result of sexual intercourse; if elsewhere, the case may be different. It may be on any part of the body, as on the top of the head or the ear, where it has been seen to result from bites received in fighting; inside

the rectum as a result of unnatural practices; on the breast of a wet nurse; or on the arm of a child vaccinated with virus from a syphilitic.

Primary stage. The chancre constitutes the first sign of the disease. It appears first as a small firm lump resembling a pimple. This may enlarge considerably or not at all, depending somewhat on its situation. It usually ulcerates slightly at its top, and shows a slight discharge, which may be thin and clear, or purulent. The chancre is nearly always single, and secondary ones rarely develop. Its base is usually hard and firm and feels like cartilage or even like bone, hence this is called the hard chancre. It may be so small as not to be noticed, and, as the patient may continue feeling well while he has it, he may not know that he is diseased until the appearance of secondary symptoms after another period of six to twelve weeks. It is not rare to have soldiers appear with well-marked secondary signs of the disease and no chancre, and denying that they have had any.

Secondary stage. The secondary symptoms are usually plainly marked and lead the patient to seek treatment. They are referred particularly to the skin and mucous membranes, and the most common of them are skin eruptions, sores in the mouth and throat and about the anus, falling of hair, slight fever, pains in the bones or joints, anemia and pallor, and various eye troubles. The skin lesions of syphilis are so numerous and of such varied character that it has been said that they can simulate all other skin diseases. The arteries, heart, and internal organs may also be affected in the secondary stage. In fact, no other known disease manifests itself in so many ways as this one, and it simulates the greatest variety of affections, including smallpox and

other eruptive diseases, malaria, liver abscess, tuberculosis of lungs, bones, or joints, epilepsy, and very many more. It is, therefore, obviously out of the question even to mention most of the symptoms here.

Tertiary stage. This stage may not manifest itself if the case is well treated in the primary and secondary stages. Otherwise it may merge with the secondary, or it may appear only after the lapse of years. It is characterized by deeper skin lesions, that show a tendency to ulcerate and form large and deep sores, by destruction of bone, the formation of swellings or tumors, and the degeneration of internal organs. Tertiary syphilis is more often mistaken for tuberculosis, cancer, and other chronic ailments, than for more acute ones. The syphilitic tumors may form in any part of the body, and those in the brain, heart, spinal cord, and other vital parts may be rapidly fatal. Syphilis is the most common cause of aneurism.

Syphilis of the nervous system. A large and important part of the harm done by syphilis was long not charged to that disease, and it is only comparatively recently that we have had the proof that enables us to know the terrible extent of its ravages on the nervous system. Beginning with nervousness and neurasthenia, that may appear early in the disease and completely destroy the happiness and comfort of the patient and his family, the number of cases of disease of the nervous system due to it is very large indeed, and embraces a great variety of manifestations. Among these may be named many varieties of paralysis, muscular atrophy, many chronic headaches, about one fourth of all cases of insanity, all cases of general paralysis or paresis, probably all locomotor ataxia, and many of blindness and brain tumor.

Period of contagiousness. Syphilis is transmissible in any of its stages; highly so in the first, more so in the second, and but slightly in the third. The time of greatest danger is that during which there are sores, with open moist surfaces, in the mouth, the nose, on the genitals, and about the anus; and it is advisable, in military service, to confine in hospital men who present such lesions. At other times, if they are kept under observation by a medical officer and continue their treatment, they may safely mingle with their fellows and do full duty.

Length of treatment. A large proportion of syphilitic cases are inadequately treated and remain uncured because of the very general tendency of patients to neglect treatment or to stop it entirely as soon as they are free from discomfort and from disfiguring lesions. The disease may, in rare instances, be cured by a single dose of salvarsan or neosalvarsan, but in the majority of cases that is not so, and treatment must be continued for a period of months or years. Even when brought under temporary control and apparently cured, the disease may still exist and merely be latent, to manifest itself later in the form of aneurism, locomotor ataxia, insanity, or some obscure trouble. There is much evidence to show that different strains of the *Treponema* tend to localize in different tissues, one strain in the skin, for instance, another in the blood vessels, another in the nervous system. This corresponds to the observed fact that many cases of aneurism, locomotor ataxia, and general paralysis are to be found in persons who had few, slight, or no skin lesions with their syphilis. It is therefore very important that the continuance and energy of treatment should not be allowed to depend

on the mere presence or absence of skin lesions, and that other means of determining whether the disease exists should always be used. Of such other means the Wassermann test is now most widely known and most generally effective. Treatment should be continued until that test becomes negative and remains negative for some months. The test should be repeated at intervals of about six months for two years after treatment has been discontinued, and in the event of the test showing a recurrence, treatment should be resumed. When a man has been free from symptoms of disease and has had a negative Wassermann reaction for two years, it may be considered safe for him to marry, though it must be borne in mind that there is even then a chance of his developing symptoms later.

MIXED INFECTIONS

One may be simultaneously infected with two or all of the venereal diseases, and in such instances the more quickly developing gonorrhœa or chancroid masks the presence of the chancre, and great surprise may result when the secondary symptoms of syphilis become manifest. Occasionally the chancre develops inside the urethra and occasions a slight discharge which may be mistaken for gonorrhœa, or the latter disease may coexist. In either event the chancre may be overlooked. More frequently, however, the confusion arises from the coexistence of soft and hard chancres. It is generally believed by men having venereal sores that the soft sore is never syphilitic, and that it always arises within ten days, while the hard chancre is always syphilitic, and never appears within ten days. These are usually true as related to pure single infections. But the viruses

of soft chancre and of syphilis may both enter the skin at the same point, in which case a soft and ulcerating sore may develop early and be followed by a large suppurating bubo, a thing not occurring in pure syphilis, and may heal under local treatment, leaving no induration, or only a slight one that is ascribed to inflammation. The syphilitic virus nevertheless continues its work and in due time the secondary symptoms develop. Some soft sores, especially those burned with acids, have a base of inflammatory tissue that may greatly resemble the hard base of the syphilitic sore.

So difficult is the differentiation of syphilitic from non-syphilitic venereal sores, by the appearance alone, that most careful practitioners do not definitely decide that a given sore is syphilitic, and therefore do not begin constitutional treatment until the diagnosis is made by the finding of the *Treponema*, by a positive Wassermann reaction, or by the occurrence of secondary symptoms. These things appear in the order named, and, as it is important that treatment should begin as early as possible, they are for this purpose valuable in the same order.

SUPPLEMENT

THE PREVENTION OF MENTAL AND NERVOUS DISEASES

CHAPTER XVI

THE PREVENTION OF MENTAL AND NERVOUS DISEASES

THE amount of inefficient army service and the number of discharges because of insanity and nervous diseases are sufficiently great to justify and to demand a brief discussion of those troubles and of what may be done by the officer or enlisted men to prevent or avoid them. For this reason the main factors influencing their occurrence will be mentioned and the preventive measures, so far as such are known, pointed out or made self-evident.

THE PREDISPOSING CAUSES

Heredity. Bad heredity is probably the largest single factor in the causation of these diseases, and it is manifestly the one over which society in general has least influence and the person inheriting has none.

We may say of heredity, though, that it is not always damning in its influence; a good many normal persons and a considerable proportion of brilliant ones are of stock that, from a biological standpoint, can only be considered bad. At the same time many persons who do show the evil effects of bad inheritance are not necessarily insane, epileptic, or useless because of "nervousness," but they stand closer to the stage of incapacity than do normal folk, are more heavily handicapped in the race of life, and lie under the greater necessity for guarding themselves from evil influences.

Heredity is a factor in most of the disabling functional disorders of the nervous system, including the two major groups of insanity known as dementia precox and manic-depressive insanity, epilepsy, hysteria, and nervous instability, and those stoppages of development that result in the states known as imbecility and feeble-mindedness, all of which are found in the army.

Education. Education, its lack, or the improper direction of it, exercises a very great influence on the development of mental and nervous diseases. It acts first by leading directly to the formation of proper habits of thought and conduct, and, secondly, by imparting a degree of knowledge that dissipates, or tends to dissipate, the ignorance in which false beliefs, groundless fears, and misdirected enthusiasms flourish. The earlier proper measures of education are undertaken, the more effective they are in accomplishing the great and important result of teaching the individual moderation and self-control, and many a spoiled or incorrigible child becomes a less useful citizen, or passes to the congregation of the incompetents, for lack of the loving but firm and wise parental training that every child is entitled to and should get. "He that ruleth himself is better than he that taketh a city," but his chances of ever doing either are not very good unless he be taught early to rule himself. The army itself is a great educational institution, and, though its training comes late and its methods are inelastic and prove harmful to some of the unstable ones for whom they are not well adapted, it disciplines and strengthens and makes useful citizens of quite a number who might never become such without the self-control and regularity of life they learn therein. Officers should try to make discipline conform

to individual needs, and should exercise all their patience in getting the recruit started in the right way of training.

Age. Age is an important factor in determining the time of onset and the type of insanity. The type most frequently seen in the army is that known as dementia precox, and it is most common because the large majority of soldiers are in early manhood, the time at which it is particularly apt to show. It may occur as early as puberty and occasionally after the thirtieth year. Another large group, manic-depressive insanity, is particularly apt to recur from thirty-five to fifty, and the involutional insanities, those due to arterial sclerosis and the degenerative processes of old age, occur after fifty as a rule.

Habits. Habits are of the greatest importance in the prevention and control of nervous diseases. Education is a failure if it does not lead to the formation of good habits, such as are helpful to the individual, to society, or to the race. Habits become characteristics, characteristics make up character, character is what a man is, so that we may truly say that a man of good habits has built his character and his very being on a solid foundation, and the difference between stability and instability of mind and character may sometimes be, in the final analysis, a difference of habits. There are some habits, however, that directly lead to disease or poisoning which act as exciting causes of insanity, and some others that develop into characteristics so constantly found in insanity that they may be considered an essential part of it.

Characteristic of all insanity is an intense egotism, a centering in self of all thought and all natural phe-

nomena, a selfishness that alters the whole world or the whole universe in order to allow it to act upon or for the individual. Whether he be exalted or depressed, a king or a worm, God or the devil, a Saviour or the worst of sinners, he is at least the center of things, a tremendous *ego*. It is obvious that habits of thought or action that encourage egotism and selfishness, such as introspection, disregard of the rights of others, undue sensitiveness, suspiciousness, seclusiveness, brooding, anxiety, and undue worrying are harmful in this as in other directions. Harmful, also, as tending to instability, are undue love of excitement and constant seeking for variety, change, and outside amusements. Improper sexual habits, such as masturbation, sexual perversions, sexual images of thought, are harmful in two ways; by bringing about frequent states of excitement, and by producing a mental state of depression, shame, feeling of unworthiness, fear, and suspicion that others may learn the facts, all such as to upset the proper self-confidence and self-respect so essential to poise, self-control, and clear thinking. Habits of indulgence in drink and harmful drugs, especially the former, constitute probably the largest single factor except heredity in the causation of insanity, and will be discussed later, while those habits predisposing to syphilis have been considered.

On the other hand, it may be stated that there are no greater preventives of insanity than those measures of conduct and the cultivation of those virtues which we all at heart recognize as good and desirable, however much our conduct points to the contrary. Among physical habits and practices thus helpful we may mention chastity, regularity of bowels, of sleep, food, and exercise of body and mind, sobriety and moderation in

general, temperance in all things, and total abstinence from things known to be harmful. Among mental traits to be encouraged are a healthy interest in religion (and by "healthy interest" is meant such as leads to unselfishness, helpfulness to others, faith, hope, charity, and cheerfulness), good reading, good thinking, broad sympathies and wide interests, and *courage*. The amount of insanity and of nervous breakdown in which lack of courage or "loss of nerve" is a main characteristic is very large.

THE EXCITING CAUSES

Alcohol. Easily chief among the exciting causes of insanity and nervous diseases is alcohol. "It is a strange commentary upon human frailty that all the poisons which assail man through accident and the dangerous trades in which he must engage, and all the poisons which are elaborated within his system, as in nephritis, diabetes, thyroidism, and acromegaly, are together responsible for but a small fraction of the number of cases of mental disease due to his deliberate ingestion of one poisonous substance — alcohol." Not only does alcohol directly and alone cause a large amount of insanity, but it is the last straw that serves to break the suffering and already weak back of many a person whose nervous organization is congenitally weak. A very large percentage of cases of dementia precox and of other forms of insanity first manifest signs of disturbance after alcoholic excitement. Furthermore, such individuals are apt to be particularly susceptible to the influence of alcohol and to be disturbed by relatively small amounts of it.

The more common alcoholic nervous disturbances,

varying from mere impairment of will power to "tremors," "horrors," and "jim-jams," are unfortunately only too well known. As stated before, the person inheriting a predisposition to nervous unbalance is under a heavy handicap and must take great care to avoid harmful influences, and there is no influence that he should more carefully avoid than that of alcohol.

Other poisons. Poisoning by lead, mercury, and some other metals may cause insanity, neuritis, and other disturbances. The frequency and speed with which the habitual use of morphine, cocaine, chloral, and other narcotic drugs undermine the will, the powers of application, and the morals of their users and make nervous wrecks of them are all too familiar. Addiction to such drugs is akin to drunkenness and is in itself an evidence of weakened mind and disordered nervous system.

Body poisons. The normal body produces poisons which it is ordinarily able to get rid of or to neutralize without harm to itself, but when, by reason of disease, such as Bright's disease, diabetes, or cirrhosis of the liver, these are not excreted as in normal conditions, or when, by reason of other diseases, as of the thyroid gland, they are elaborated either in too great or too small amounts, nervous disturbance up to and including complete mental upset may result. It is possible that the poison retention resulting from mere constipation might be influential in similar directions, and it is a matter of frequent observation that an attack of depression or of irritability may be caused by constipation and relieved by a purge. The pregnant state causes insanity relatively frequently, though whether because of retained poisons or of disturbances of ductless glands or for other reasons is not known. Epilepsy is greatly

influenced by the kinds and amounts of food ingested and by the state of the excretions, and there is much to show that it is at least associated with a condition of self-poisoning.

Circulatory disturbance. When because of heart disease, arterio-sclerosis, stoppage of a vessel from any cause, or of anemia, the circulation in the brain or the amount of blood carried to it is interfered with, it suffers, and the result is impaired or disturbed mentality, that may amount to actual dementia or insanity.

Syphilis. Syphilis is the only infectious disease that causes a very large number of cases of insanity and of other severe forms of nervous disease. About one fourth of all cases of insanity, as observed in soldiers at the Government Hospital for the Insane and in civilians at the Danvers (Mass.) State Hospital and in a number of other institutions, are syphilitic; probably one fifth are due wholly to this disease. In addition, as stated before, all or practically all locomotor ataxia, many types of paralysis, much neurasthenia, and a vast number of other cases of nervous disease are of the same origin.

Other infections. Typhus, typhoid, malaria, meningitis, pneumonia, and other infections may cause insanity, neuritis, paralysis, and other nervous disturbances, but the frequency with which they do so is relatively slight as compared with syphilis. Diphtheria is very apt to cause paralysis of the throat or of the nerves supplying the heart. Sleeping sickness is principally a disease of the nervous system. Pellagra, though not definitely known to be caused by infection, has so many points of resemblance to infectious diseases that it may be mentioned here. It very commonly has mental disturbance as one of its most striking features.

Trauma. Injury, especially injury to the head, may be the direct, exciting cause of insanity, epilepsy, hysteria, or minor troubles. It, like most of the infectious diseases mentioned, is more apt to have such effect in persons predisposed to nervous disturbance.

Shell shock. Even mental or emotional shock may do this. During the recent World War, when conscription was in force in all of the great countries and many unfit and unsuitable individuals were taken into military service, functional nervous disorders occurred in such numbers as to give them a prominence which they had not had before and, because the earlier cases attracting attention came from battlefields where heavy bombardments had occurred and most of these cases gave a history of shell explosion close to them, the name *shell shock* was applied to them and soon gained a great vogue. As a matter of fact, most cases of shell shock are not due to physical injury. There is a small proportion of cases in which the symptoms may be due to actual physical injury of the nervous system as a result of physical shock. The great majority of cases are pure neuroses, nervous exhaustion, neurasthenia or hysteria, and they may and occasionally do arise long before a battlefield is seen, especially the latter two, as a result of anxiety or fear acting upon a poor nervous organization. Usually the battlefield was the place of origin and the explanation was found in the fact that the paralysis, blindness, deafness, mutism, tremor, or whatever else the symptoms might be, represented the soldier's only avenue of escape from an intolerable situation. A man possessed by fear of death, but driven forward by discipline, self-respect, pride, and duty, and kept by those sentiments from running away and mani-

festing his fear, at length lost his conscious control of his will or of some of its manifestations and passed into a state of blindness, deafness, paralysis, or other condition which served as a compromise between his conflicting emotions, cutting out of his consciousness the terrifying sights or sounds, or rendering him unable to continue fighting, and so sending him out of battle with a clear conscience and without manifestation of fear. And this, it must be remembered, was neither a voluntary nor a conscious assumption of symptoms by the patient. It is as real to him as the loss of a leg would be, and it will so remain until his mind in one way or another becomes convinced to the contrary. Or, in some instances, the man's mental and nervous and often his physical force was exhausted by prolonged hard work and strain. A good sleep, extending at times for twenty-four hours, would often restore such cases. In other instances the occurrence of frightful dreams or the renewal in dreams of terrifying experiences might cause the patient to waken as exhausted as when he went to sleep, and to enter upon a true neurasthenia. These conditions were all known in peace-times, but were rarer, because few men were subjected to such extraordinary strain, worry, danger, or horror as war causes. The susceptibility to such nervous states varies. The great importance of inborn or acquired tendency to nervous disease cannot be over-emphasized, but it must be admitted that shock due to terrifying or horrifying conditions in war may induce hysteria in sound individuals, in men whose records show that they are not of timid disposition or nervous make-up.

By having special hospitals near the front for the treatment of these cases much better results are attain-

able than if they be sent back at once, as with delay in getting proper rest and proper mental attitude the disability tends to become fixed. Profiting by English and French earlier experience, we established special divisional units for their handling in the First Army, A.E.F., with the result that, after the battles of Sainte-Mihiel and the Argonne, sixty-five per cent of such cases were returned to their divisions within three days, twenty per cent returned after short stays in advanced hospitals, and only fifteen per cent got back as far as the S.O.S., and but a small proportion of these were invalided home.

Environment. Persons strongly predisposed to mental trouble may be upset by relatively trifling things, of a character, as already indicated in regard to alcohol, infections, and trauma, such as would not disturb a person of sound nervous constitution. Likewise apparently unimportant worries, such as might be occasioned by anxiety as to obtaining or retaining a position, by an unjust accusation, by a disturbing social engagement, or by a mere fear of making a social blunder, may act as a determining factor in mental disease. It may be readily understood, then, that the change of environment that occurs on enlistment, the transfer possibly from a home where the individual's weakness has been supported, his peculiarities overlooked, his deficiencies supplied, to a barracks where the men have no interests or acquaintances in common with him, where his weakness is imposed upon, his peculiarities pointed out and his deficiencies jeered at, may prove more of a burden than his weak mentality can bear. Add to that the pangs of homesickness, the brooding over the apparent injustice of disciplinary measures, the worry incident to learning drills and new duties, the fear excited by lonely

sentry duty, the feeling of isolation caused by practical jokes, and possibly the actual petty tyranny of an unfair non-commissioned officer, and it is not remarkable that weak men break down under it. Later the real stress of campaign, the excitement of real combat, the fear caused by real danger to life or limb may prove the disturbing factor.

Incentive. The influence of a great incentive and a high enthusiasm in keeping up morale and lifting men above the influences of environment was well shown in the tendency to lowered morale and the great wave of homesickness which swept over the A.E.F. after the signing of the armistice with Germany in November of 1918.

"A deep and impelling motive for work or sacrifice — that of winning the war — had suddenly to be replaced by other moving forces and the progress of replacement was not always wholly successful." It took both sense and strength of character to stick to plain, inglorious duty and realize that it was worth while, and not to abandon one's self to thoughts of home and family and feel that one was abused by having to continue making sacrifices when there was no longer a great object in sight for which to make them. "There is no more efficacious measure against painful introspection than pleasurable activity." Games, competitions, amateur theatricals, visits to leave areas, educational courses, and similar diverting activities had an excellent effect and restored a good spirit. It was a fine example of what wise handling can accomplish with the spirits of men, and it shows that the well-officered organization should really prove a help to many men of nervous make-up and afford them a helpful, guiding control which they cannot furnish for themselves.

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